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The effects of human-wildlife conflict on conservation and development: a case study of Volcanoes National Park, northern Rwanda

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Thesis Submitted to the University of Dublin, Trinity College, for the

Degree of Doctor of Philosophy

Discipline of Geography
School of Natural Sciences

The University of Dublin
Trinity College
2014
Declaration

I, Shane Mc Guinness, confirm that this thesis has not previously been submitted as an exercise for a degree at this or any other university and is entirely my own work. Where information is not my own, I confirm that this is acknowledged within the text of this thesis. I agree to deposit this thesis in the open access institutional repository of the Library of Trinity College Dublin and agree that this library may lend or copy this thesis upon request, subject to Irish Copyright Legislation and the conditions of use and acknowledgement of this library.

Signed: Shane Mc Guinness
Date: 23/05/14
Rising global population pressure and associated increases in demands for natural resources have resulted in heightened pressure on areas containing valued biodiversity. Efforts to assist the development of marginalised communities, however, often contravene measures aimed at the sole conservation of these areas. As such, tension often exists between the aims of conservation and development, preventing equal gains in the two. Inflaming this tension is the interaction between economically marginalised communities and protected fauna, which can result in human-wildlife conflict (HWC) of varying forms, including disease transmission, livestock depredation, crop loss and property damage. As humans can be seen as the common denominator of HWC, social and political considerations must be made at both proximal and distal levels: HWC is not merely a quantifiable ecological problem. This study has focussed on one form of HWC, crop raiding, and the constraints imposed by it on conservation and human development efforts, using a forested protected area in tropical Africa as case study.

Volcanoes National Park (VNP), in northern Rwanda was chosen as the centre-point of a case study to analyse in depth the effects of HWC on conservation and development. The location of VNP within the Albertine Rift of eastern central Africa and its inclusion of a string of high altitude volcanoes have resulted in extensive and largely endemic biodiversity, some of which has substantial economic value through nature-based tourism, such as the mountain gorilla (Gorilla beringei beringei). VNP also constitutes part of a protected area spanning the three nations of Uganda, Rwanda and the Democratic Republic of the Congo, which together form a potentially unstable constellation of conservation sites. Further, population densities in Rwanda are thought to be the highest in mainland Africa, with particularly high levels adjacent to VNP. This study has investigated the form, level, extent and determinants of HWC on the margins of VNP, its effects on conservation and tourism and the mitigation measures in place to minimise adverse impacts.

Given the ecological, social and political drivers and consequences of HWC, and the difficulty in assessing the ecological conditions within VNP that may also be factors, no single method was adopted to investigate this case study. Instead, a mix of qualitative and quantitative investigative tools constituted the methodology of the current study, including preliminary interviews with key stakeholders, focus groups and administered surveys with residents farming land near VNP, quantitative monitoring of crop raiding events across an entire year and a boundary survey of mitigation efforts in place. Major drivers of crop raiding were identified through re-aggregation
and triangulation of qualitative data, while spatial analysis of quantitative data revealed spatial variability in its extent and magnitude.

Though crop raiding by forest-dwelling animals was the predominant manifestation of HWC around VNP and was perceived as a significant livelihood restriction by residents living near the park, crop raiding was only one of several factors adversely impacting livelihoods around VNP. Other factors included land shortage and agricultural restrictions. The intensity of HWC was spatially clustered along the length of VNP boundary. Several determinants of the extent and magnitude of HWC were identified, including the species of wild animal, the crop grown, the season planted and the proximity to VNP. Furthermore, a lack of agricultural control and the intervention of private agro-industry were found to exacerbate the effects of this conflict. As a result of inadequate revenue sharing and limited opportunities for employment in related areas, support amongst local farmers for both conservation and tourism initiatives was found to be low and is undermined further by HWC. Mitigation of this around VNP is currently limited to active guarding and the construction of largely-inadequate physical barriers, though both these measures incur significant and varied costs on park-adjacent communities. More novel mitigation measures are recommended in this case, in addition to the improvement of current methods. Direct compensation for crop raiding damage is being implemented though is likely to result in more complex forms of conflict. As tested in this study, introduction of a locally-funded insurance scheme may be a more viable solution.

Three important conclusions have been drawn from this study. First, HWC has a significant impact on conservation and development, through reduced support for conservation and restricting development of park-adjacent communities by diverting limited resources towards conflict mitigation. Second, though ecological data are important in describing conflict, levels of HWC and its impacts are not predominantly determined by local factors, but have broader political and economic drivers such as national policies aimed at agricultural expansion and the demands of private industry. Some of these, such as regional political instability and current agreements regarding agricultural activities, may have their roots in the more distant past. Finally, though identified as a constraint on conservation and development, HWC represents one of several complex limitations to the development of marginalised communities and the conservation of valued biodiversity. This case study reveals that reconciling conservation and development aims where HWC is a factor are likely to necessitate a more holistic approach to HWC analysis and mitigation than those previously adopted.
I would first like to thank my supervisor, David Taylor, for several years of motivation, guidance and support, without which this study would not have been possible. I am also grateful to Anna Davies, for her guidance and supervision at such a late stage of this project. I would further like to acknowledge the kind financial support of the Irish Research Council for Science Engineering and Technology, especially in such economically trying times.

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The journey of the last three years has taken many turns. Throughout all of this, however, my family - close and extended - have stood by me, providing encouragement, respect and counsel, in addition to a dose of reality and cop-on when needed. Thus, to my parents Helen and Brendan, brothers Graham and Barry, sister-in-law Fiona and the newest addition to the McGuinness clan, Oisin, I offer this thesis as recompense for all the irrationality and absence.

*Murakoze cyane and go raibh maith agaibh* to one and all. It’s been emotional.
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<tr>
<td>ADMADE</td>
<td>Administrative Management Design</td>
</tr>
<tr>
<td>ANICO</td>
<td>Animateurs de Conservatour</td>
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<td>BI</td>
<td>Birdlife International</td>
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<td>CAMPFIRE</td>
<td>Communal Area Management Programme for Indigenous Resources</td>
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<td>CBC</td>
<td>Community-based Conservation</td>
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<td>CCT</td>
<td>Community Conservation Teams</td>
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<td>CI</td>
<td>Conservation International</td>
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<tr>
<td>CIA</td>
<td>Central Intelligence Agency</td>
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<td>CGIS</td>
<td>Centre for Geographical Information Systems</td>
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<td>CLT</td>
<td>Conservation Land Trust</td>
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<tr>
<td>CVM</td>
<td>Contingent Valuation Methodology</td>
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<tr>
<td>DC</td>
<td>Dichotomous Choice</td>
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<td>DEM</td>
<td>Digital Elevation Model</td>
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<tr>
<td>DFGFI</td>
<td>Dian Fossey Gorilla Fund International</td>
</tr>
<tr>
<td>DRC</td>
<td>Democratic Republic of the Congo</td>
</tr>
<tr>
<td>EC-APAAT</td>
<td>European Commission - African Protected Areas Assessment Tool</td>
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<tr>
<td>EEEGL</td>
<td>Enterprise, Environment, and Equity in the Virunga Landscape of the Great Lakes</td>
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<td>FAO</td>
<td>Food and Agriculture Organisation</td>
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<tr>
<td>FBPA</td>
<td>Forest-based Poverty Alleviation</td>
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<tr>
<td>HWC</td>
<td>Human-wildlife conflict</td>
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<tr>
<td>ICDP</td>
<td>Integrated Conservation and Development Programme</td>
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<tr>
<td>IDW</td>
<td>Inverse Distance-weighted Interpolation</td>
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<tr>
<td>IGCP</td>
<td>International Gorilla Conservation Programme</td>
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<td>IUCN</td>
<td>International Union for Conservation of Nature</td>
</tr>
<tr>
<td>JADF</td>
<td>Joint Action Development Forum for Tourism and Conservation</td>
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<td>LEFT</td>
<td>Local Ecological Footprint Tool</td>
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<tr>
<td>MINAGRI</td>
<td>Ministry of Agriculture and Animal Resources</td>
</tr>
<tr>
<td>MGVP</td>
<td>Mountain Gorilla Veterinary Programme</td>
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<tr>
<td>MMR</td>
<td>Mixed Methods Research</td>
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<td>NGO</td>
<td>Non-governmental Organisation</td>
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NP – National Park
OLS – Ordinary Least Squares
PPM – Provision Point Mechanism
RATIN – Regional Agricultural Trade Intelligence Network
REDD – Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
RDB – Rwanda Development Board
REMA – Rwanda Environment Management Authority
RoR – Republic of Rwanda
RPF – Rwandan Patriotic Front
RDF – Rwanda Defence Forces
Rwf – Rwandan Francs
SACOLA – Sabyinyo Community Livelihoods Association
SEAGA – Socio-economic and Gender Analysis Programme
RTWG-OTF – Rwanda Tourism Working Group – On the Frontier
TBPA – Transboundary Protected Area
UN – United Nations
UNDP – United Nations Development Programme
VIF – Variance Inflation Factor
VNP – Volcanoes National Park
ViNP – Virungas National Park
WTO – World Trade Organisation
WTP – Willingness to Pay

Focus Group Participant and Survey Respondent Quotations

Focus Groups: (Sector_Gender_Respondent#)

B = Bugeshi, J = Jenda, S = Shingiro, K = Kinigi, N = Nyange, R = Rugarama
e.g. (K_M_M7) = Kinigi focus group, male, participant number 7

Surveys: (Sample sector, number of transect, position on transect)

Bug = Bugeshi, Jen = Jenda, Shi = Shingiro, Kin = Kinigi, Nya = Nyange, Rug = Rugarama
e.g. (Kin29.2) = Kinigi Sector, 29th survey transect, 2nd administered survey
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"We shall never achieve harmony with land, any more than we shall achieve absolute justice or liberty for people. In these higher aspirations the important thing is not to achieve, but to strive"

1. Introduction

1.1 Overview
Increasing global population, coupled with greater resource demands, has resulted in significant limitations to conservation and development goals on the margins of protected areas, particularly in middle and low income countries. This has raised an increasingly fraught debate between conservation of dwindling biodiversity and the development of economically-marginalised communities. Typifying this disparity of ideals, conflict between protected fauna and developing communities through a variety of mechanisms is of increasing concern, through its ability to reduce support for conservation programmes and impose additional resource pressures upon communities. The role played by this human-wildlife conflict (HWC) in exacerbating the problematic conservation-versus-development debate thus requires urgent consideration.

The following thesis examines the effect of HWC on conservation and development, using a suitable case study of HWC around a protected area in the developing world. Volcanoes National Park (VNP), northern Rwanda, supports extremely valuable biodiversity. However, surrounding farmland is currently under heavy population pressure, in addition to being subject to many of the existing development concerns of tropical Africa. Thus, by characterising current HWC on the margins of VNP, identifying the drivers of this conflict, examining the consequences of this conflict and identifying existing mitigation measures in place, this study intended to provide greater understanding of the effects of HWC on conservation and development initiatives globally.

1.2 The aim and objectives of this study
In light of the above concern, the aim of this study was to establish the extent to which HWC constrains both conservation and development around protected areas, using Volcanoes National Park (VNP), northern Rwanda, as a case study.

To achieve this main aim, five research objectives (ROs) were implemented:

RO1 – Determine the form, level and range of human-wildlife conflict experienced by farmers adjacent to VNP

RO2 – Establish the likely determinants of conflict, including spatiotemporal variation

RO3 – Determine the impacts of HWC on VNP tourism and conservation
RO4 – Ascertain the nature, extent and effectiveness of current mitigation and appraise potential future solutions

ROS5 – Assess the potential of an insurance scheme to mitigate losses due to conflict

1.3 Thesis Organisation
Chapter Two of this thesis first examines the justification for conservation of biodiversity, the challenges of combining human development with this and identified limitations to these goals. This chapter then focuses specifically on human-wildlife conflict as a limitation to conservation and development, giving an overview of the forms this can take and the measures commonly adopted to reduce its impacts. Finally, this chapter then explores the value of using mixed methods research and the more holistic world view of political ecology to characterise the effects of HWC on conservation and development.

Chapter Three of this thesis gives a comprehensive background to the case study chosen for this project. This first focuses on the proximal factors potentially influencing the nature, extent and magnitude of conflict with park-adjacent farmers and its effect on conservation and development. This is achieved through giving a comprehensive background to VNP itself and then by describing in-depth the communities bordering VNP. Following this, wider factors affecting the conservation of VNP and the development of park-adjacent communities are described, including national and regional concerns.

Chapters Four and Five of this thesis then describe the methodology adopted to achieve the objectives and overall aim of this study. Chapter Four first justifies the methodological framework chosen, and gives an overview of this. This chapter then describes the collection of primary and secondary field data and the various considerations required for this. Chapter Five describes the collation of data collected through these methods and then details the varied analyses used to investigate the specific research objectives of this study.

Chapters Six and Seven of this thesis present the findings of the above analyses. Chapter Six outlines the results of specific methods, separating relevant findings of analyses into sections addressing each research objective of this study. Chapter Seven then uses these groups of results to synthesize an overall result for each research objective of this study.

Chapter Eight of this thesis individually discusses in-depth the findings of each research objective and makes assertions based on these findings. This is supported through appropriate referral to current literature. This chapter then presents a combined discussion of the overall research aim of
this thesis, using referral to individual research objectives to support this. This chapter then discusses the methodological limitations of this thesis and presents options for future research to improve our understanding of how HWC constrains conservation and development.

Finally, Chapter Nine draws on the above discussions based on the findings of this thesis and presents a conclusion to the overarching research question it has asked. Overviews of the results of each research objective are then given to show how these findings have supported the overall conclusion drawn.
2. Background to Research

2.1 Overview
The following chapter has several key aims. Firstly it will position this project in the wider field of natural resources, their value and the variability in this value globally. The success and failures of current natural resource conservation strategies will then be discussed, including the key factors dictating this success, such as anthropological, psychological and economic limitations. Moreover, this chapter will introduce the limitations to conservation and human development caused by human-wildlife conflict (HWC) and the role played by differing worldviews in defining and resolving this conflict. The effectiveness of a political ecology approach to conflict mitigation is then discussed, which is finally contextualised in the current case study of HWC on the margins of Volcanoes National Park, Rwanda.

2.2 Nature and natural resources
Prior to discussing mechanisms through which conservation may be effectively achieved, it is useful to define what is meant by a natural resource. Similarly, it is important to understand how these resources are differentially valued to better describe conflicts arising from their utilisation, legally or otherwise.

2.2.1 Natural resources and valuation

2.2.1.1 Defining natural
The common view of nature is as a non-spatial concept (Schaffter et al., 2010); an entity we lie within, but are not of. A consequence of this has been the ideological separation of humans and nature (Manfredo and Dayer, 2004). The idea of nature as simply “a cultural construct dependent on human understanding” (Angermeier, 2001) serves to exacerbate this removal. Furthermore, Angermeier’s description of human society and the acquisition of goods as “an unnatural ecological behaviour (which) impinges on conservation goals” suggest that society has lost sight of a required goal and that “technology acquisition is an end in itself”. Thus nature, or naturalness, based on conventional values of nature which use biodiversity, evolutionary distinctiveness, ecosystem services or productivity, may be fltering as perceptions moves towards a simpler definition of nature as merely excluding human technology (Angermeier, 2001).
2.2.1.2 Natural resources, value and the impetus to conserve

Resources provided by nature do not exist without adding value to society; “resources are not, they become” (Zimmerman, 1951, p.35). Without the wide suite of values attributed to natural resources, their existence would remain arbitrary to humans. Similarly, aspirations of conservation can rarely be achieved without delineating the resources required for both our survival and the survival of particular species (and assemblages thereof). Thus, placing a value upon these is often seen as the first step in achieving conservation, resource management or development goals.

Natural resources offer substantial financial gain through the commoditisation of mineral and organic assets, resulting in human wellbeing benefits. Monetary value can be easily applied to such commodities traded on existing markets. Non-use of natural areas, individual species and resources for which a market does not currently exist, such as ecosystem services or cultural value, are more difficult to attribute value to (Angermieier, 2001; Hanley et al., 2001; Jakobsson and Dragun, 2001). For this reason valuation techniques for non-market goods have been developed. For example, quantification of public perception of an increased number of vultures (Gyps fulvus) in protected areas (Becker et al., 2007) found that there are “solid economic arguments to invest in charismatic wildlife species, even if their population size is above its critical survival threshold level” (Becker et al., 2007, p.340), despite the fact that these measurements are not a monetary valuation. Other studies have revealed that participants often disagree with placing a monetary value on nature (e.g. Clark et al., 2000), even though there is an economic benefit to conserving this through tourism.

Some see the commodification of nature as an inevitability and the only way to place value, and hence ensure protection of natural resources (Hoffman and Rohde, 2007), by allowing it to pay its way as a world currency through ‘green developmentalism’ (McAfee, 1999). Recent advances in payment for ecosystem services and the associated REDD (Reducing Emissions from Deforestation and Forest Degradation) programmes point towards an advancement of this mind-set. As Gillingham and Lee (2003) observe, local people must attach positive value to wildlife to ensure support for its existence and commercial management. However, when valuation is attempted in regions of the world with poorly understood natural resources, or where humanitarian pressures are prominent, justification for conservation becomes tenuous.

Aside from the cultural or economic, it has been argued that there exists an intangible holistic reason to value nature, in that “naturally evolved biotic elements... are fundamentally more valuable than artificial ones” (Angermieier, 2001, p.377). Indeed from a psychological perspective, moral obligation is often cited as a predictor of decisions to conserve over financial or cultural values (Neumann, 2004; St. John et al., 2010).
This ecocentric worldview could also be seen as a luxury of a developed economy. As Angermeier notes, “we cannot view nature except through culturally-tinted lenses” (2001 p.376). Culture strongly influences, and sometimes defines, the value attributed to natural resources, which subsequently dictates the way in which communities interact with these resources and react to conflicts. Some observe that when ownership or responsibility of resources is lost, through the process of establishing protected areas, for example, social norms which had acted as internal regulators become widely disregarded (St. John et al., 2010). Where a person acquires responsibility, however, the probability that a given environmentally-friendly behaviour will take place greatly increases (Ojea and Loureiro, 2007), through an awareness of consequence (Stern et al., 1993). This particularly applies to indigenous communities and the cultural value they attribute to native ecosystems (Angermeier, 2001).

2.3 Conservation challenges

The drivers of conservation actions could be for personal gain through ecosystem service provision, nature-based tourism benefits (Simpson, 2008; Sandbrook and Adams, 2012), or could be more closely linked to moralistic mitigation of guilt (predominantly on the part of those regions whose natural resources are already substantially degraded). Whether based on anthropocentric self-preservation or ecocentric worldviews based on moral arguments, the methods through which conservation is achieved are often based on similar approaches. The following section outlines common conservation strategies and problems in reconciling conservation and development in economically-marginalised regions of the world.

2.3.1 Fortress conservation versus community-based conservation

Historically, conservation was based on the exclusionary principles of colonial systems (Buscher and Whande, 2007); protected areas established for hunting and aesthetic purposes through removal of local land-users coupled with stringent control of resource use by the occupants of surrounding land (Adams and Hutton, 2007). These ‘fortresses’ of conservation, based on the sole aim of re-establishing dwindling ecosystems or populations of charismatic megafauna, have been an undoubted success. As Baldus succinctly notes, “parks work” (2001, p.1). Large-scale private examples of this continue to emerge in the post-colonial present (Buscher and Whande, 2007), such as the purchase of a vast tract of former Patagonian farmland by an international NGO (Keller, 2007), a project founded on Naess’ principles of Deep Ecology (1973). In this example, a programme of land purchases, reintroductions, replanting and compensation for human relocation, aims to “prioritize the importance of ecosystems and all forms of life therein,
regardless of their use to man” (CLT, 2012). Clearly, some see segregation as the only viable mechanism to guarantee perpetuity, adhering to the concept that the human race has no right of dominion over other species (Nash, 1989). Private extractive industry, national governments and ecotourism ventures are well-recognised proponents of the exclusionary worldview of conservation. However, few authors identify the increasing demand from conservation researchers (Sunderlin et al. 2005), through exerting pressure on national governments and the private sector to conserve these resources through either complete exclusion or highly reduced local use of resources.

Though the achievements of total human exclusion can rarely be denied on conservation grounds, this is often at the expense of communities; ‘conservation against the people’, as Baldus asserted (2001). Political change and lessening acceptance of colonial exclusionary ideals has led to a reduction in support for fortress-model conservation (Berkes, 2004; Buscher and Whande, 2007). Additionally, increasing global human population, particularly on the margins of protected areas (Wittemyer et al., 2008), means that the existence of areas not influenced, or relied upon, by humans is decreasing. In this way, the success of conservation is increasingly linked to the level of local support it receives and the nature of appropriate benefits it offers communities (Emerton, 2001; Smith and Bangs, 2008). There is also an increasing awareness of the moral argument against subjugating or excluding indigenous peoples from resources or historical land claims. As Hill notes, conservationists must ensure that “the individuals who bear the costs of any conservation policy are also those who subsequently benefit from them” (Hill, 2000, p.314). This shift in approach is also related to the realisation that a large proportion of species ranges and natural resources are located outside of protected areas (e.g. Hoare, 2000), presenting a system unsuitable to fortress conservation models.

As a result, focus has broadened from sole fortress conservation to the inclusion of communities in conservation decision-making, policy implementation and actions, through community-based conservation (CBC). Recent assessments have outlined the varied degrees to which communities can be involved in this (Nemarundwe and Richards, 2002; Adams et al., 2004). This spectrum ranges from passive participation, where community representatives (though involved in the process) have little say in the direction of conservation research or representation for vested interests, to collective action where interdisciplinary methodologies and inclusive learning processes mean local decision-making is maintained (Nemarundwe and Richards, 2002). Though Brockington and others have expounded on its benefits (Brockington, 2002), and in so doing near-villanize fortress conservation, CBC is not a panacea. Its claims of lying harmoniously between the extremes of anthropocentric and ecocentric worldviews remains ambitious. Some claim that a “hollow, romanticised image of the community” (Goldman, 2003, p.834) is often at play, where
the appearance of conservation organisations to donors and governments takes precedence over actual conservation success. Devolution of control over protected areas and the potential revenue they generate has not been achieved in most cases and the organisation of a large number of CBC programmes is still regarded as a “top-down distribution of privileges to community members, rather than active participation” (Goldman, 2003, p. 839). In this way, conservation models remain site-specific.

2.3.2 Conservation challenges in the developing world

Closely linked to conservation goals are the development challenges with which they often coincide. The spatial convergence of low-income populations and valuable natural capital is becoming increasingly recognised (Sunderlin et al., 2005) and renders CBC paradoxical, especially when involving marginalised poor and powerful outsiders. Furthermore, many regions of threatened biodiversity globally coincide with those of highest human population density (Myers et al., 2000; Vedeld et al., 2012). Given that human population growth around protected areas can be nearly double that of other areas (Wittemyer et al., 2008), conservation in a developing world setting requires priority action.

It has, however, been recognised that wildlife and the substantial nature-based tourism revenue this may generate can be an important contributor to national income and in meeting development targets (Emerton, 2001). Attempts to combine development goals with conservation targets in the developing world include forest-based poverty alleviation (FBPA) (e.g. Sunderlin et al., 2005), integrated conservation and development programmes (ICDP) (e.g. Archabald and Naughton-Treves, 2001), community-based natural resource management (CBNRM) and varied other programmes linking conservation and development (Barrett and Arcese, 1995). The discontinuities in the combination of strategies adopted to achieve poverty alleviation and conservation have been highlighted however (Adams et al., 2004), as oftentimes these strategies are confused or inappropriate. Dangers inherent with any common resource, and self-regulation thereof, also remain (e.g. Hardin, 1968). For example, the CAMPFIRE (Communal Area Management Programme for Indigenous Resources) programme of Zimbabwe has given partial autonomy over natural resources to local communities, providing alternative incomes for those experiencing loss as a result of living with wildlife (Logan and Moseley, 2002). Though successful in providing these, it has since been assessed as uneven in distribution and subject to high levels of corruption and the influence of elites (Logan and Moseley, 2002; Frost and Bond, 2008). CAMPFIRE has, however, provided a model for more direct payments for conservation, in the form of contemporary Payments for Ecosystem Services (PES) programmes (e.g. Jack et al., 2008).
2.4 Human-wildlife conflict

Conservation takes various forms and is influenced heavily by development challenges. A further complication in the success of both conservation and development, however, is the influence of HWC. Following a brief definition and overview of the forms HWC can take, this section focuses on one prominent cause of conflict; the foraging of planted crops by wildlife species and factors dictating the variability in this. It will then discuss its prevalence and intensity, and common methods adopted to curtail its effects on conservation and development efforts.

2.4.1 Defining human-wildlife conflict

Human-wildlife conflict (HWC) occurs “when the needs and behaviour of wildlife impact negatively on the goals of humans or when the goals of humans negatively impact the needs of wildlife” (Madden, 2004, p.248). Labelling this as conflict has been contested, however, as it runs the risk of “constrain(ing) the way problems are defined and limits the array of potential solutions available” (Peterson et al., 2010, p.79). The so-called terministic screen this creates is seen to limit the potential for resolution, by diverting attention away from underlying political and governance incongruities (Peterson et al., 2002) and creating a problem where before there may have simply been an environmental pressure (Fall and Jackson, 2002; Priston, 2008). Regardless, the success of some conservation initiatives in recent decades, with growing human populations on the margins of protected areas (Wittemyer et al., 2008), has led to an increase in reported interactions between wildlife and marginalised subsistence farmers. This is a growing concern when planning either human development actions or conservation management. In addition, as suitable habitat now increasingly exists within a mosaic of anthropogenic land-uses (Hartter et al., 2011), losses as a result of interactions between society and wildlife species take increasingly varied forms.

2.4.1 Forms of human-wildlife conflict

2.4.1.1 Disease transmission

Transmission of zoonotic disease from wild species ranging outside of protected areas can result in direct human mortality or significant loss through mandatory culls of livestock. For example, badgers (Meles meles) have been identified as a latent reservoir of bovine tuberculosis in both the developing and developed worlds, causing regular culling of entire cattle herds (Cosivi et al., 1998; Donnelly et al., 2003). Similarly, transmission of pathogens from wild bison (Bison bison) to cattle outside Yellowstone National Park continues to cause conflict between farmers and conservation initiatives (Kilpatrick et al., 2009). From a conservation perspective disease transmission to protected species also generates conflict. For example, populations of giant panda (Ailuropoda melanoleuca) and mountain gorilla (Gorilla berengei berengei), both highly endangered and susceptible to human diseases, are put under increasing risk from transmission of disease from
tourists carrying harmful foreign pathogens (Qiu and Mainka, 1993; Sandbrook and Semple, 2006; Palacios et al., 2011).

### 2.4.1.2 Livestock depredation
Carnivorous and omnivorous wildlife species (especially those wide-ranging and of larger body size) regularly predate upon livestock, resulting in significant financial loss (e.g. Kissui, 2008). This ranges from developed world examples such as wolf depredation on ranched and free-ranging domestic animals (Boitani et al., 2010; Lance et al., 2010) to developing world depredation of pastoral livestock (Inskip and Zimmermann, 2009; Li et al., 2013).

### 2.4.1.3 Property damage
Furthermore, damage to property is a common cause of conflict between human populations and wildlife species, through damage to infrastructure such as buildings, boundaries and utilities (Thomassen et al., 2001; Ogra, 2008; Thapa, 2010) or vehicle collisions (Found and Boyce, 2011; Neumann et al., 2012).

### 2.4.1.4 Human death and injury
Human injury and loss of life also occurs on a limited basis, usually through either exposure by guarding against other conflicts (Sitati et al., 2003; Gubbi, 2012) or direct human depredation (Packer et al., 2005), though the latter is rare.

### 2.4.2 Crop raiding
The dominant category of human-wildlife interactions, however, is the loss of arable crops or plantations through wildlife foraging (Dickman, 2010). This presents particular pressures in those areas where dense human populations, land restrictions and costs prevent pastoral herding of livestock, making subsistence tillage the sole means of survival. This is further exacerbated in regions bordering protected areas which harbour significant populations of herbivorous and omnivorous species.

#### 2.4.2.1 Why raid crops
Factors dictating animals decisions to raid could be based on a paucity of resources within a protected area (Naughton-Treves et al., 1998), or the carrying capacity for a species within that area being reached (Van Aarde and Jackson, 2007). Conversely, analysis of crop raiding in Uganda (Tweheyo et al., 2005) and Sumatra (Linkie et al., 2007) suggested that decisions to raid crops were not based on reduced availability of forest forage but on the increased availability of preferred crops along the forest’s margins. In other words, animals may simply prefer the forest-agricultural boundary over areas deeper into a protected area, where natural forage may be more readily available than crops (Butynski, 1984).
There may also be an evolutionary propensity to raid based on body size and genetic fitness, as the energetic payoff could outweigh the risk associated with ranging outside natural habitat. Modelling of African elephant (*Loxodonta africana*) raiding, for example, found that males of similar ages that raided crops were significantly larger than those that did not (Chiyo *et al.*, 2011). As energy from crops leads to longer musth and greater body size, crop raiding becomes selective (Sukumar, 1991; Chiyo *et al.*, 2011). Similarly, chimpanzee (*Pan troglodytes*) raiding is seen as an adaptive response to a food source which is highly concentrated, predictable, nutrient-rich and is easily obtained (Tweheyo *et al.*, 2005).

### 2.4.2.2 Variation in raiding

Variation in crop raiding incidence and magnitude is dictated by a variety of factors. Foremost, levels of damage and associated financial loss can vary significantly between the species of animal raiding, though this may be on the same crop. Baboons (*Papio anubis*) around Budongo Forest, Uganda, for example, removed the entire plant when feeding on the pith and stem of maize (*Zea mays*), resulting in a complete loss of the crop (Hill, 2000), whereas antelope species browsing on the leaves of the same perennial plant resulted in much less financial loss. Differing group ecologies can further dictate whether groups of social animals raid (Strum, 2010), while some suggest that the decision to raid may be at the individual animal level (Hoare, 2000; Fall and Jackson, 2002; Gubbi, 2012). Though large and charismatic megafauna are predominantly blamed for damage, and may inflict greater damage per individual per visit, greater net damage is often...
inflicted by smaller animals in larger numbers such as invertebrates, birds and rodents (Nchanji, 2002; Kagoro-Rugunda, 2004; Pérez and Pacheco, 2006). The difficulty in seeing and implicating smaller animals leads to larger, more noticeable species being disproportionately implicated. For example, cane rats (*Thryonomys spp.*) and birds were found to cause the greatest loss in rural villages of Cameroon, yet go largely unreported in studies (Nchanji, 2002). Similar biases were observed when comparing Peccary (*Tayassu spp.*) to bird damage in Bolivia (Pérez and Pacheco, 2006) and elephant to baboon damage in Uganda (Mackenzie, 2012). Some estimates of small animal raiding attribute up to 77% of damage to these seldom-implicated taxa (Pérez and Pacheco, 2006). The gender of fauna involved also plays a part in many megafauna raiding species, with significant gender differences found in elephants (Chiyo *et al.*, 2011) and buffalo (*Syncerus caffer*) (Hay *et al.*, 2008).

Proximity to an area supporting wildlife species defines the numbers of raiding individuals willing to risk raiding, in addition to the suite of species encountered as raiders (Naughton-Treves, 1998; Hill, 2000; Kagoro-Rugunda, 2004). Elephant and buffalo are known to raid greater than two kilometres outside of protected areas (Nchanji, 2002; Plumptre, 2002), while primate raiding is predominantly observed under 500m from cover (Hill, 2000; Tweheyo *et al.*, 2005; Mackenzie, 2012). Body size thus seems to be a useful metric for expected raiding distance. Similarly, Asian elephant (*Elephas maximus*) raiding around a southern Indian reserve was highest in those villages with the most protected area frontage (Gubbi, 2012), showing the effects of protected area shape in combination with proximity. Additionally, those living closer to protected areas tend to be more economically marginalised and therefore exposed to losses incurred through crop raiding (Plumptre *et al.*, 2004; Bush *et al.*, 2010).

Temporal variation is also important. For example, damage to crops is considered greatest during or just before harvest when crops are mature (Sukumar, 1989; Tweheyo *et al.*, 2005). Similarly, banana (*Musa spp.*) raiding by large mammals was significantly higher in the dry season at Lake Mburo NP, Uganda (Kagoro-Rugunda, 2004), where foraging of tuber crops was made easier in the soft, damp soil of the wet season. Wider investigations of seasonal rainfall have, however, shown both positive (Linkie *et al.*, 2007) and negative (Tweheyo *et al.*, 2005) correlations with crop raiding frequency, suggesting that the use of climate as a predictor of crop raiding should only be made where the seasonal ecologies of species involved are well understood. Diurnal variation has also been identified in several studies. For example, crop damage in Nepal by a suite of raiding species was perpetrated exclusively at night (Thapa, 2010) while primate raiding is more commonly observed during daylight hours (Hill *et al.*, 2002a).

The availability of appealing forage on the margins of protected areas is largely dictated by the land-use of these regions and may dictate the suite of raiding species (Karanth *et al.*, 2012).
Pasture, for example, is of little benefit to foraging primates or ungulates, while forest browsers may be overexposed in an intense arable agriculture matrix (Naughton-Treves et al., 1998).

Socio-demographic characteristics of human populations are perhaps the most important component of crop raiding variation; as Manfredo and Dayer note, “humans are the constant in HWC” (Manfredo and Dayer, 2004, p.318). Thus, the variation in human behaviour and attitudes across social groups can affect perceptions of HWC and influence support for conservation (Tweheyo et al., 2005; Dickman, 2010). In some case studies, numbers reporting crop raiding were significantly related to ethnicity and wealth class (Harrter et al. 2011) while higher population densities have led to more intense agriculture and greater impact when raiding does occur (Tweheyo et al., 2005). In addition, Newmark et al. (1994) showed that densely populated areas experience greater proportions of raiding from smaller species than larger species. Conversely, lower human densities were found to facilitate less opposed entry into farmland (Kagoro-Rugunda, 2004) and allow deeper penetration into an agricultural matrix (Naughton-Treves, 1997).

2.4.3 The impacts of crop raiding

Human-wildlife conflict is defined by its effect on human actors, either conservation practitioners or human populations living in close proximity to wildlife. The following section outlines the effects of crop raiding specifically on the livelihoods of farmers living in close proximity to wildlife and the concurrent effect on conservation efforts, if present.

2.4.3.1 Livelihood implications

Conflict between wildlife species (protected or otherwise) and human society is most often identified by the amount of monetary loss this causes, leading to significant livelihoods impacts. Annual damages relating to interactions with wildlife in the United States of America have been estimated at over US$3 billion (Conover et al., 1995). Additionally, though regional estimates of crop loss are difficult to calculate, African elephants have been estimated to cause upwards of US$60,000 worth of damage annually in Namibia alone (Mulonga et al., 2003). Similarly, though badgers have been held responsible for the transmission of bovine Tuberculosis, they additionally cause in the region of £20 – 40 million of annual loss through crop damage in England and Wales (Moore et al., 1999).

However prevalent this problem is globally, its effects on communities is rarely equal. Though fauna surrounding protected areas in African, South-east Asian, and South American countries "has no more impetus to engage in conflict than wildlife in developed nations" (Peterson et al., 2010, p.79), socioeconomically marginalised communities in developing nations, predominantly residing close to areas of high conservation value (Myers et al., 2000), are much more exposed to
losses incurred through crop raiding. Finding solutions should thus be of a higher priority in developing countries, where lives are threatened through hunger and sickness caused by HWC (Mulonga et al., 2003). As Cozza et al. have asserted (1996, p.329), human-wildlife conflict cannot be viewed “in isolation from the socioeconomic context in which it occurred”.

Specifically, perturbation of livelihoods in developing regions is exacted through several mechanisms. Loss of crops intended for domestic consumption or sale is a well-documented conflict. With increasing productivity owing to advancing agricultural technologies, the unit value of parcels of land and the crops grown on these are increasing (Fall and Jackson, 2002), especially in developing countries under high human population pressures. Less well addressed, however, are the opportunity costs associated with crop raiding (Tchamba, 1995; Hill, 2004; Barua et al., 2013), such as the reduced household time of parents as a result of guarding crops or constructing defences (Hill, 1997; Hill, 2000; Emerton, 2001; Kagoro-Rugunda, 2004; Tweheyo et al., 2005), reduced school attendance of children guarding crops (Kagoro-Rugunda, 2004) and exposure of farmers to vector-borne diseases by remaining outdoors (Hoare, 2000). Raiding species may also harbour zoonotic disease potentially transmissible to bordering human populations (Kilpatrick et al., 2009; White and Ward, 2010). In some cases, HWC imposes limitations on the collection of water and firewood through fear of large animals or of government reprisals for interacting with protected species (Kagoro-Rugunda, 2004; Barua et al., 2013). Furthermore, consideration of ‘social assets’ in HWC case study, such as status, honour or popularity (Mailath and Postlewaite, 2006) purports that raiding of farmers’ crops may diminish local perceptions of an individual’s ability to secure livelihoods (Barua et al., 2013).

Additionally, by limiting crops grown around protected areas, HWC has been known to reduce dietary diversity and associated malnutrition (Hoare, 2000; Weladji and Tchamba, 2003; Akankwasah, 2008; Barua et al., 2013). Under extreme levels of conflict, organised human relocation may be instigated (Treves and Karanth, 2003), potentially resulting in further socio-political and cultural conflict. Adding to this, there is a disproportionate effect felt across gender and age divides (Ogra, 2008) as women, being at the centre of agricultural systems in many developing countries, are more exposed both physically and financially to the costs of conflict. Prashant (2004) has found that 68% and 66% of deaths caused by animals in northern India were, respectively, children under the age of 15 and women. An additional and more subtle effect of conflict is the emergence of reliance upon shared revenue from tourism initiatives, leading to a reduction in livelihood autonomy (Sandbrook and Adams, 2012) as authorities exercise control over its (often unequal) distribution. This is exacerbated through ‘leakage’ of benefits to those not directly affected (Sandbrook, 2008).
Though extremely rare, isolated examples of positive HWC effects on livelihoods have been noted. For example, by raiding coconut (*Cocos nucifera*) plantations in Zanzibar, red colobus (*Procolobus kirkii*) fulfil a ‘pruning effect’ leading to a higher overall yield (Siex and Struhsaker, 1999). Similarly, cashew (*Anacardium occidentalis*) farmers of Guinea-Bissau have observed chimpanzees stripping and piling nuts, making harvesting easier (Hockings and Sousa, 2012), in a form of sympatric utilisation.

**2.4.3.2 Conservation implications**

The declining popularity of conservation initiatives as a result of these livelihood impacts is well documented in recent case studies (Nyhus et al., 2000; Plumptre, 2002; Tweheyo et al., 2005; Linkie et al., 2007; Thapa, 2010). Indeed, warnings have been made on the risk of losing the support for conservation of those living next to protected areas (Plumptre, 2002; Gillingham and Lee, 2003; Smith and Bangs, 2008), especially in systems where sufficient levels of agricultural autonomy allow for protest and modification of farming practices (Bulte and Rondeau, 2005; Smith and Bangs, 2008) or around settlements within protected areas illegally or close to its margins (Linkie et al., 2007). A lack of support for conservation may ultimately result in active antagonism towards conservation efforts and the resumption or intensification of hunting and habitat degradation (Rondeau and Bulte, 2007). This may lead to retribution killing of implicated wildlife or deliberate impedance of conservation initiatives (Nyhus et al., 2000). Reprisal attacks commonly occur on individual animals in reaction to continued conflict with protected areas, such as the hunting of bears in China (Liu et al., 2011), elephant in India (Gubbi, 2012) and baboons in Kenya (Strum, 2010) as direct retribution for crop loss. Furthermore, conservation infrastructure is also targeted, such as the destruction of wildlife and livestock fences in Kenya (Okello and D'Amour, 2008), though this may also be linked to discontent over exclusion from natural resources such as cattle grazing or firewood (Buscher and Whande, 2007).

Though crop raiding may induce negative attitudes towards protected areas (de Boer and Baquete, 1998), an erroneous assumption is that these attitudes inevitably lead to negative behaviours, such as reprisal attacks or illegal resource use (St. John et al., 2010). This neglect of potential moral and cultural drivers of community conservation, in favour of an over-simplified economic decision, is often made (Emerton, 2001) and highlights the need for a more interdisciplinary approach to conflict mitigation (White and Ward, 2010).
2.5 Existing mitigation strategies

An increasingly varied suite of methods aimed at preventing and mitigating conflict currently exist, expanding through technological advances, academic research and growing public reporting and perception of HWC (Fall and Jackson, 2002). The following section outlines these approaches and their success and potential drawbacks, through varying case studies.

Figure 2.2: A range of common HWC mitigation strategies adopted in the developing world including a) wire fence, b) drystone wall, c) active guarding by children and d) the positioning of traditional bee hives near protected areas.

2.5.3 Physical barriers

The most common form of mitigation is the imposition of physical barriers, including walls, fences and trenches (fig 2.2). Though useful, particularly in impeding larger animals (Hayward and Kerley, 2009; Hoare, 2012), the quality, suitability and maintenance of a barrier defines its effectiveness (Gubbi, 2012). Often, the consistency of barriers is limited (Thouless and Sakwa, 1995; Thapa, 2010), in addition to an inability to halt most avian and invertebrate raiders. Assessments of Bolivian fencing, for example, have recommended that the integrity of fences be checked daily to maintain effectiveness, especially on steeply-sloped or unstable terrain (Pérez and Pacheco, 2006). Maintaining local access to areas of rich natural resources could explain a lack of support
for defence maintenance, as it is these gaps created by wildlife damage, water courses or
inclement weather, which may provide access to protected resources for neighbouring human
communities.

The cost of these barriers additionally limits their use. For example, electric elephant fences in
Zimbabwe and Kenya can cost up to US$1,476 km$^{-1}$ and US$4,000 km$^{-1}$ respectively (Thouless and
Sakwa, 1995; Hayward and Kerley, 2009), while fences for primate exclusion in Bolivia can cost up
to US$3,570 km$^{-1}$ (Pérez and Pacheco, 2006). A more economical option may be the use of bio-
fencing to protect crops. Stands of Mauritius thorn bush (Caesalpinia decapetala), Sisal (Agave
sisalana) and Euphorbia spp., among others, have been identified as a cheap and effective means
of deterring large African mammals (Hill et al., 2002a; Andama, 2005) and Indian Rhinoceros
(Rhinoceros unicornis) (Thapa, 2010). The disadvantages of these, however, include the time
required for adequate growth and the death of older plants. Alternatively, a region of agricultural
landscape can serve as an effective barrier against foraging (Naughton-Treves, 1998; Hoare and
Du Toit, 1999).

2.5.3 Buffers

The planting of non-palatable crops, intermediate habitat or unsuitable habitat on the margins of
protected areas can additionally provide protection. Though these rarely physically restrict
movement of animals, they remove the desire to raid, by lessening the advantages of crop raiding
over the risk of exiting a protected area. Changing cultivable land to pasture or banana plantation
has reduced mammalian raiding around Kibale NP Uganda, for example (Naughton-Treves, 1997)
while, the cultivation of mentha (Mentha spp.) around crops in Nepal has acted as an effective
deterrent (Thapa, 2010). Commercial plantations have similar effects, such as tea (Camellia
sinensis) (Mulley and Unruh, 2004) and coffee (Coffea spp.) (Chiyo et al., 2005) cultivation around
Ugandan protected areas. The planting of chilli (Capsicum spp.), in addition to being a viable cash
crop, is similarly effective in Zimbabwe (Parker and Osborn, 2006). Cash crop buffers, however,
are reliant upon local acceptance and established market linkages (Priston, 2008). Similarly,
though not always unpalatable to potentially raiding species, a buffer of community-regulated
forestry has been implemented in several cases of HWC (Plumptre et al., 2001; Thapa, 2010). In
some cases this was merely found to extend the secondary habitat of raiding species into
agricultural land (Hill, 2000). Finally, a more contentious method of buffering against raiding
animals has involved giving more exposed land between villages and protected areas to
immigrants, as in the case of the Batoro of Western Uganda (Naughton-Treves, 1997; Mulley and
Unruh, 2004), thereby reducing the effects of HWC felt by existing residents to the direct
detriment of more marginalised peoples. This example further highlights the hidden cultural
consequences of HWC and measures to mitigate this.
2.5.3 Active guarding

Guarding crops from raiding species at times of heightened vulnerability is a strategy often adopted (Kagoro-Rugunda, 2004; Tweheyo et al., 2005; Linkie et al., 2007; Strum, 2010; Thapa, 2010), usually involving a combination of other deterrents including noise, bright colours or pungent smells. Though time-consuming, it has been shown to significantly reduce loss (Gillingham and Lee, 2003; Kagoro-Rugunda, 2004), in some cases reducing raiding by 75%. In addition, this requires little or no training and limited monetary investment. Recent assessments have recommended that guarding be increased as an alternative to expending scarce resources on improving barriers (e.g. Pérez and Pacheco, 2006). The use of dogs, flaming sticks, guard towers and even donkeys have additionally been adopted (Muruthi, 2005; Linkie et al., 2007; Thapa, 2010). The risks of this strategy are well recognised, however, especially when guarding against large or dangerous animals. Furthermore, the associated opportunity costs of guarding are rarely considered as limitations to its use (Barua et al., 2013).

2.5.4 Diversionary resources and aversive forage

The successful use of diversionary forage to protect forest plantations (Sullivan and Sullivan, 2008) suggests that providing less valuable forage as an alternative to raiding species is a viable strategy. Similarly, providing alternative water sources for large mammals has reduced conflict in certain East African cases (Muruthi, 2005). Given its use of one scarce resource to protect another, however, developing world examples of this strategy are rare. Conditioned taste aversion (CTA) could be a viable adaptation of this and has shown marked reductions in conflict events (Baker et al., 2007). Though more widely used for livestock depredation, its potential for use with crop raiding species in tropical regions has been investigated with varying efficacy (e.g. Muruthi, 2005; Strum, 2010).

2.5.5 Novel deterrents

Most mitigation strategies implemented are rapidly habituated to by raiding species (Sitati and Walpole, 2006), reducing the efficacy of more general mitigation measures. Consequently, several studies have pressed for sets of mitigation measures as varied as the raiding taxa implicated (Strudsrod and Wegge, 1995; Karidoza and Osborn, 2005). Recent developments in this have included solar blinkers for wild boar raiding (Schlageter and Haag-Wackernagel, 2011), broadcasting the sounds of disturbed bees (King et al., 2007), the release of specific unappealing pheromones, sirens coupled to infrared triggers, remote sensing using collars and capsaicin repellent sprays for primates (Hill et al., 2002a).
2.5.6 Translocation and targeted removal

Failing impedance or deterrence, an alternative lies in the removal of specific problem individuals or groups, through lethal control or translocation (Sukumar, 1991; Sillero-Zubiri and Switzer, 2001; Walter et al., 2010). Recent assessments of large problem mammal relocations, however, have revealed that costs are prohibitively high (Sillero-Zubiri and Switzer, 2001; Fontúrbel and Simonetti, 2011), that reductions in raiding are not guaranteed (Nelson et al., 2003) and that the ecological effects on small island populations of protected species may be too great (Tuyttens and Macdonald, 2000). Similarly, mitigation through lethal removal is losing acceptance in the developed (e.g. Walter et al., 2010) and the developing world (Fall and Jackson, 2002) through the realisation of the cultural and tourism value of these individuals.

2.5.7 Financial solutions

Monetary compensation of crop and livestock loss is widespread in more developed economies to mitigate HWC losses and takes two forms; direct compensation for loss and infrastructural investment (Cozza et al., 1996; Nyhus et al., 2003; Boitani et al., 2010; Walter et al., 2010). Contrary to this, examples of compensation initiatives in developing economies have been strongly criticised (AFESG, 2002; Ogra and Badola, 2008), owing to bureaucracy, excessive costs and corruption. Some further posit that compensation may lead to increased habitat clearance, immigration, increases in crop prices and a greater economic impetus to poach wild animals (Rondeau and Bulte, 2007). The imposition of performance payments as opposed to traditional compensation (Nyhus et al., 2005) may provide a solution, though there remains an inherent moral hazard in both, where those eligible for compensation are much less likely to also invest in measures to reduce loss. It has thus been recommended that attention to local conditions, intense monitoring, solid boundaries, effective enforcement and inclusion of local knowledge in planning should be a prerequisite to compensation (Rondeau and Bulte, 2007). Some assessments further claim that improved mitigation rather than compensation would be more effective in fostering a pro-conservation stance (Mackenzie, 2012), though not necessarily in reducing the livelihood impacts of HWC.

As with any payment scheme, the risk of fostering dependence and cheating is not easily avoided. To circumvent this, common fund insurance policies have been proposed (Clark et al., 2000) and in some cases implemented (Hussain, 2000; Morrison et al., 2009). These take the form of a local contribution paid by those at risk, in amounts determined by their exposure to this risk, and are regularly co-funded by ecotourism revenue (Hussain, 2000). By virtue of being locally sustained, the desire to falsify damage and cheat relatives or neighbours is reduced. In addition, tailoring these local funds to locally-experienced exposure to HWC and affordability reduces distortion in cost and risk caused by costly HWC events elsewhere. Furthermore, such schemes may reduce
expenditure of time and finances on other costly mitigation efforts. Conversely, Plumptre (2002) highlighted how domestic animals and their capital value are used as insurance against damage by raiders, dampening the economic shock associated with conflict. The establishment of community land trusts has also been forwarded, to buffer the effects of HWC damage (Muruthi, 2005).

2.5.8 Community engagement
Muruthi (2005) proposed winning the hearts and minds of those affected by HWC to encourage support for conservation initiatives and reduce retaliatory attacks on wildlife. Despite the common human factor in all conflicts, recent studies have shown that social science methods are rarely adopted to resolve these conflicts (Hill, 2000; Austin et al., 2010; White and Ward, 2010). Although conservation practitioners increasingly utilise local knowledge in conflict mitigation, there has been a failure to involve communities in subsequent actions and appraisal (Allendorf et al., 2012; Vedeld et al., 2012). Some community approaches are being taken to resolve HWC, however, including education, consolation payments, and tourism revenue sharing (Leader-Williams and Hutton, 2005; Vedeld et al., 2012). Programmes such as the Zimbabwean CAMPFIRE and Zambian ADMATE have pioneered this approach in Africa, with varying degrees of success (Logan and Moseley, 2002; Frost and Bond, 2008; Elliot and Sumba, 2011). A resultant shift in perceptions has been observed in some cases, with poaching stigmatised as harming the potential for revenue sharing of neighbours (Bond, 2001). The tangible and equitable distribution of appropriate community benefits, as a means of mitigating HWC losses, is a concern in this case (Emerton, 2001; Sitati et al., 2003). For example, communities living near Amboseli NP in Kenya, receive less than 1% of revenue generated through tourism (Norton-Griffiths, 1996), despite experiencing significant conflict with the park in addition to forgoing use of its resources.

2.5.9 Policy modification
In addition to bottom-up conflict reduction measures, top-down policy modifications are also used to strengthen mitigation actions. Muruthi (2005) has suggested an increased level of policy harmonisation as a means of reducing conflict and improving protection, especially with regard to protected areas spanning international borders (Bronkhorst, 2005), though participatory policy-making is encouraged over unilateral government planning (Clark et al., 2000; Allendorf et al., 2012). Changes to data collection policy, such as the development of a streamlined rapid assessment programme for raiding (Strum, 2010), have also been suggested. In addition, modification of policy governing the land-use of agricultural matrices near protected areas have been proposed as mitigation (Muruthi, 2005), such as the establishment of communal farms and land-use consolidation.
2.5.10 Toleration

Finally, as Dickman acknowledges “conflict studies are extremely hard to conduct in a way that does not risk inadvertently raising conflict” (2010, p.7), both in terms of highlighting a previously unseen problem or implementation of inequitable solutions. Therefore, some authors have proposed toleration as the most effective and cheapest in terms of monetary cost and run-in time (Fall and Jackson, 2002). Given the limitations of developing world economies and the pressing development challenges therein, this expectation could be viewed as a first world luxury.

Clearly, significant variability exists in the nature, level and extent of wildlife foraging of arable crops. There are additionally a wide suite of measures aimed at preventing HWC or lessening its impact on those affected. The application of many of these, however, is limited by practicalities such as cost, labour, suitability and longevity. Additionally, many of these have heightened restraints when applied in a developing world context. A broader approach to human-wildlife conflict characterisation and resolution, and its effects on conservation and development goals, is thus required.

2.6 A political ecology approach to conflict resolution

The worldview of political ecology offers a potential framework around which to construct more robust solutions to human-wildlife conflicts. This section outlines the benefits of interdisciplinarity to conflict resolution, using a political ecology perspective.

2.6.1 The requirement for interdisciplinary solutions

Following trends in other academic spheres, a push towards interdisciplinary HWC mitigation has emerged, encompassing aspects of the social sciences, economics, law, political science and ecology (Hazzah, 2006; White and Ward, 2010). Addressing issues of HWC previously relied upon quantification of effects and solution-building based on observed independent findings. This dismissal of experience-based (heuristic) problem-solving continues to limit the effective treatment of conflict, by disregarding local knowledge and the views of stakeholder groups who benefit from a resource, but who may be unequally exposed to the costs associated with living next to these resources. As such, interdisciplinarity is increasingly adopted in “defining management pathways that will reduce conflict and are therefore more likely to be successful” (White and Ward, 2010, p.624). As St. John et al. state, through a proposal for collaboration between conservationists and behavioural psychologists, “we must refrain from reinventing the wheel and ensure that we learn from the wealth of knowledge held by other disciplines” (St. John et al., 2010, p.665).
A reclassification of conflict case studies following analyses of recent literature (Peterson et al., 2010), found that the majority of cases describing HWC could more accurately be described as human-human conflict, arising through differing viewpoints on resource use (Teel and Manfredo, 2010). As Manfredo and Dayer (2004, p.321) observe, “by understanding the societal factors which give rise to different wildlife value orientations, it is possible to predict trends of shifting orientations, which can be used in planning for future conditions”. Thus, assessments of HWC should equally consider human factors such as local grievances, the vested interests of social elites and inequality and corruption in benefits systems, especially given the poorly understood opportunity costs of conflict (Barua et al., 2013).

Furthermore, selection and use of individual mitigation measures often relies on site-specific political concerns (Fall and Jackson, 2002). Thus, appropriate mitigation requires a broader consideration of conflict than quantification alone (Dickman, 2010; White and Ward, 2010); one requiring collaboration with national and international stakeholders, including governmental and non-governmental organisations, conservation scientists, communities and private industry (Adams and Infield, 2003; Simpson, 2008) and consideration of local and regional political conditions.

2.6.1 The political ecology approach

It is increasingly recognised that conservation conflicts and the social causes and consequences of these are inextricably linked (Adams and Hutton, 2007). Furthermore, the discrepancy of worldviews between sociological investigation and empirical conservation science can often be better resolved using the framework of political ecology. Originally coined in 1935 (Thone, 1935), ‘political ecology’ concerns the social, political and economic drivers and consequences of environmental issues. Though an established academic field of political ecology did not emerge until much later, its focus has centred on the “political dynamics surrounding material and discursive struggles over the environment in the third world” (Bryant, 1998). Modern exponents of the field argue that robust solutions to both development and conservation challenges can only be found through the acknowledgement that the relationship between protected areas and adjacent communities is fundamentally human and political in nature (Logan and Moseley, 2002; Manfredo and Dayer, 2004; Adams and Hutton, 2007). This approach includes a consideration of the proximal and distal factors driving human-wildlife conflicts. In a developing world context, proximal factors leading to conflict may include local cultural heterogeneity, land governance, inequities in natural resource use and private industry interventions (Logan and Moseley, 2002). Distal factors may include strategic national policy, regional political stability and the influence of international governments and non-governmental organisations.
More holistic approaches to HWC, such as that offered by political ecology, can offer a better description of conflict than either natural or social sciences could independently (Adams and Hutton, 2007) by combining economic loss, stakeholder vested interests, socioeconomic conditions of victims and the ecological factors dictating exposure to HWC.

2.7 This study

The continued access to natural resources is complicated by differing worldviews of use and non-use, with indigenous communities and the cultural value they attribute to indigenous ecosystems often suffering first. Conflict between protected species and human populations is a prominent consequence of this differential, one example of which is the foraging of food crops by wildlife species that are often of conservation and tourism value. This is exacerbated by an increasing spatial convergence of low-income populations and protected species, leading to interactions between wildlife and marginalised subsistence farmers. Not only is the success of conservation often dependent upon the support won by conflict resolution, but continued development requires conflict mitigation beyond overreliance on tourism revenues. This is particularly important for HWC around transboundary protected areas involving a larger set of stakeholders. Thus, studies of HWC in the developing world, where a combination of development targets and continued conservation is sought, are a priority.

Though an ecological understanding of HWC is helpful to conflict resolution, the important role played by human behaviour and attitudes across social groups in influencing perceptions of conflict is increasingly acknowledged. Thus, robust solutions require strong interdisciplinarity, such as that offered by the social, ecological and economic perspectives of political ecology. Using a transboundary protected area (TBPA) in eastern central Africa as a case study, this study aimed to show the constraints of HWC on conservation and development. Through investigation of the extent, magnitude and determinants of this conflict, and the effectiveness of current mitigation strategies, this case study serves as a model for conflict resolution in other developing world scenarios where human development and biological conservation are both priorities.
3. Study Site

3.1 Overview
This chapter outlines the study location chosen for this project and details the reasoning behind this choice. Specifically, this chapter covers the unique case of HWC that this site presents and existing research conducted on the proximal political ecology determinants of this, including local demographic and cultural variability. Further, this chapter addresses the distal factors affecting HWC around the chosen site, including national policy, regional political instability and regional conservation concerns.

3.2 Volcanoes National Park, northern Rwanda
There were several benefits in choosing Volcanoes National Park (VNP), in northern Rwanda, as a case study for this project. The increasing prevalence of human-wildlife conflict along its margins, its small size, well-understood ecology and good accessibility mean that VNP provides a good case study for a resource-constrained site experiencing HWC. Additionally, given the increasing human population in Rwanda and the pressure associated with this, focusing on VNP also allows consideration of human development challenges and their relationship with HWC. This section outlines the biological importance of VNP and the wider application of studying conservation and development challenges presented by HWC.

3.2.1 Background to VNP
Volcanoes National Park, located between 1° 22" and 1° 34" South, and 29° 24" and 29° 42" East (fig. 3.1), encloses a string of extinct volcanoes on the border between Rwanda, the Democratic Republic of the Congo (DRC) and Uganda, ranging from 1,850 - 4,507m above sea level. The park was originally established in 1925 as part of Parc National Albert, the first designated national park in Africa, though its size and sovereignty has changed significantly since. Founded for the protection of remaining populations of mountain gorillas (Gorilla beringei beringei) (Delvingt et al., 1990), it included what is now part of the Virungas Massif TBPA, spanning the DRC and Uganda. Park extent was increased in 1927, before being divided into the two parks of Virungas National Park in DRC (ViNP) and Volcanoes National Park in Rwanda (VNP), following Rwandan independence in 1960. The small (33.7 km²) Ugandan section, Mgahinga Gorilla National Park, was originally established as a gorilla sanctuary in 1930 and was gazetted as a national park in 1991 following extensive encroachment and clearance (Plumptre et al., 2004).
Northern and western Rwandan forest has been severely impacted by 20\textsuperscript{th} century deforestation, falling to 18.05% of its 1934 extent (Ruzigandekwe, 2009). Though VNP in Rwanda originally covered 328\textsuperscript{km}\textsuperscript{2}, this was reduced substantially through clearances for the settling of returning refugees following decades of political unrest, and the establishment of agro-industry in 1959 (7,000ha) and between 1969 and 1973 (10,000ha). This was exacerbated through World Bank-International Monetary Fund restructuring programmes of the early 1990s (Storey, 2001; WTO, 2003), when large areas of VNP were cleared for the cultivation of cash crops, giving a present-day coverage of 165\textsuperscript{km}\textsuperscript{2} (Jost, 1987; Plumptre \textit{et al.}, 2004).

3.2.2 Biodiversity importance

Despite its size, the diversity of species harboured by Volcanoes National Park is significant and increasing with research. However, exact species collections for each of the constituent parts of the Virungas Massif are unknown and most likely vary by seasonal and super-seasonal movements. Thus, most measures of biodiversity for the Virungas volcanoes span the entire TBPA.
Plant species assemblages of the Virungas Massif list 878 species (Plumptre et al., 2003), including 128 Albertine Rift endemics and five Threatened species based on IUCN classification. A recent repeat survey found 107 species unrecorded in the previous survey and 348 species entirely new to the Albertine Rift (Owiunji et al., 2005), showing the as-yet incomplete understanding of the Virungas Massif’s diversity. Of the three national parks constituting the Virungas TBPA, VNP was found to support the most diversity with 624 species (Owiunji et al., 2005). Spatial distribution of these species is highly heterogeneous, owing to the significant altitudinal variation of the Virungas volcanoes (Gray et al., 2010). This variation is increased through a mosaic of wetlands and grasslands and through the infiltration of introduced species such as black wattle (Acacia mearnsii), eucalyptus (Eucalyptus spp.), cypress (Cupressus spp.) and pine (Pinus spp.) (Owiunji et al., 2005; Ruzigandekwe, 2009).

Volcanoes National Park supports one of the few remaining populations of the Critically Endangered mountain gorilla (Robbins et al., 2012). Though historically severely threatened, with numbers as low as 324 individuals in 1989, recent censuses indicate an increase of 17%, to 380 individuals across the Virungas Massif. This growth spans a period of significant political unrest and associated poaching, but improvements in conservation and increased international awareness have most likely resulted in this growth (Gray et al., 2010). VNP additionally supports a significant population of golden monkey (Cercopithecus mitis kandti), an Endangered sub-species of the blue monkey (Grove, 2005; Butynski, 2012) which is probably only found in Volcanoes NP, Nyungwe NP and Gishwati forest.

Surveys of other large mammal densities within VNP have been restricted to incidental collection of data during mountain gorilla population surveys (Owiunji et al., 2005). Owing to safety concerns and uneven sampling effort, these estimates are not thought to represent distribution or density. Through this, however, 86 mammal species have been recorded for the Virungas Massif (Plumptre et al., 2003), including populations of African elephant (the distributions of forest and savannah subspecies overlap here (Blanc, 2008)), Cape buffalo, bushbuck (Tragelaphus sciritpus), black-fronted duiker (Cephalophus nigrifons) and hyrax (Dendrohyrax arboreus).

Additionally, the Virungas volcanoes support 294 bird species, including 20 Albertine Rift endemics and 4 IUCN Redlist species. The Massif also contains 43 species of reptile including 7 Albertine Rift endemics, 47 species of amphibians including 16 Albertine Rift endemics (9 of which are at least Threatened) and 21 species of butterfly (Plumptre et al., 2003). Despite these studies, the flora and fauna of VNP is relatively understudied, with significant misunderstanding of its flora and fauna. For example, hippopotamus (Hippopotamus amphibious) are currently listed on the European Community Land Resource Management Unit’s Volcanoes National Park database (EC-APAAT, 2008).
Given the under-appreciated diversity of species within VNP and its relatively small size, resolving conflicts with adjacent communities is imperative. Investigation of HWC in 1996 revealed significant crop damage around VNP. Buffalo crop raiding was most prominent, causing over 90% of damage within 250m of the forest edge (Plumptre, 2002). Calls have been made for compensation or benefit-sharing schemes in order to quell disquiet over levels of HWC (Plumptre, 2002). Given the altitudinal gradient of VNP, most species richness has been found to tend towards lower altitudes and its edge (Owiunji et al., 2005). As these areas are also more likely to experience human use or retaliatory actions due to conflict, they are of high priority for conflict resolution.

3.2.4 Tourism value

Given the relative accessibility of groups of gorillas in Volcanoes National Park in comparison to other populations of eastern gorillas in the DRC and Uganda (Owiunji et al., 2005), and the international attention afforded them through the efforts of Dian Fossey, gorilla trekking is now the largest earner of foreign exchange in Rwanda, having surpassed coffee and tea production in 2002 (Mehta and Katee, 2005). In 2006, the nature tourism industry of Rwanda was valued at US$33 million, the vast majority of which stemmed from highly lucrative mountain gorilla trekking (REMA, 2009). This is supplemented in VNP with visits to troupes of golden monkeys, climbing the volcanoes of Karisimbi, Biseke, Muhabura and Gahinga, and various forest activities. Being one of the key Vision 2020 priorities (RoR, 2000), tourism in Rwanda is expected to generate "US$100 million in tourism receipts in 2010, by focusing on creating high value and low environmental impact experiences for eco-travellers, explorers and individual business travellers" (RTWG-OTF, 2003). Some sources claim that this has surpassed US$200 million (Nielson and Spenceley, 2010), the majority of which can be at least secondarily related to gorilla tourism, though the precise figure earned from this species is unknown.

Given this tourism value to the government of Rwanda, impacts of HWC which threaten this resource, through direct retribution killings, increased resource use within the forest, or reduced support for conservation initiatives generally, are of great concern.

3.2.3 Broader application of this case study

Increases in world population, associated demands for agricultural land and heightened populations on the margins of protected areas point toward growing conflict between adjacent communities and conservation efforts in the developing world (Myers et al., 2000; Wittemyer et al., 2008). Volcanoes National Park presents a model for this future conflict, allowing for the development of more effective problem characterisation and the development of more robust solutions.
Furthermore, application of a political ecology world view to conservation and development challenges can be achieved here with relative ease, through well-understood political systems, comparatively-transparent administration and the inclusion of challenges to conservation presented by regional political unrest. Subsequent sections of this chapter detail the proximate and distal factors dictating the political ecology of VNP as a means of better investigating HWC on its margins.

3.3 Communities bordering VNP

This section details the communities bordering VNP, who are potentially exposed to conflict with forest-based fauna. This includes the administration of these regions, the demographics of the population, agricultural strategies adopted and their involvement with gorilla tourism.

Figure 3.2: The administration of northern Rwanda delineating - in descending size - provinces, districts and sectors. Subordinate cells are excluded for clarity. Data source: CGIS-NUR
3.3.1 Administration

Historically administrative boundaries in Rwanda were based on communities located on the tops of hills, or Collines, while agriculture was conducted in valleys between these. Colonial consolidation has removed this system, replacing it with a complex hierarchical administrative system. Revision of these administrative boundaries and nomenclature in 2006 following the 1994 genocide and associated civil war has led to extensive changes in place names and boundaries. In descending order of size, these revised delineations consist of five provinces, 30 districts, and a subordinate hierarchy of sectors, cells and villages (fig. 3.2). Four districts currently abut VNP, containing 12 sectors which are adjacent to, or within 500m of, the VNP boundary. Within these are 26 park-adjacent cells, which further contain a myriad of smaller village delineations. A further five Rwandan cells are adjacent to the boundary of Virungas National Park in the DRC and Mgahinga National Park in Uganda.

3.3.2 Demographics and culture

Most recent census estimates give Rwanda a population of 8,162,715 (RoR, 2003), though current calculations based on intrinsic growth rates yield a figure of 10.8 - 11.6 million (CIA, 2012; PRB, 2012). As such Rwanda is the most densely populated country in continental Africa and is ranked 27th globally (CIA, 2012) at circa 380 people/km². In-migration of people to the resource rich forest margins, in concert with deliberate government-driven settlement has resulted in a mean population density surrounding VNP of 590 people/km², though this is thought to exceed 1,000 people/km² in places (Bush et al., 2010). Since initial clearance and settlement, forced movement of dwellings away from the park boundary has created linear settlements following tracks perpendicular or parallel to the forest edge. This process is part of the Rwandan government policy to create population centres and centralise services, and is at varying stages of progression in park adjacent sectors (RoR, 2000).

Culture surrounding VNP is predominated by native Rwandese, formerly divided into several ethnic groups including Bahutu, Batutsi and Batwa. Having been the basis of genocidal ideology in the past, all three terms have since been outlawed, with the exception of referral to the Genocide against the Tutsi. The Batwa are a recognized pygmy people, formerly occupying the forests of eastern DRC, Uganda and Rwanda. The disenfranchisement and exclusion of the batwa community from political discourse is thought to have been largely concealed in Rwanda (Beswick, 2011). From a people who were historically treated indifferently in Rwandan society (Reyntjens, 1996), following the genocide batwa communities have been subject to stigmatisation, abuse and marginalisation (Plumptre et al., 2004; Tumushabe and Musiime, 2006). Currently, several batwa communities are present around VNP, though their integration into non-
batwa communities is limited, with most receiving assistance from the government of Rwanda (Plumptre et al., 2004) as ‘historically-marginalised peoples’.

The most widely spoken languages in the region of this study are Kinyarwanda, Swahili, French, English and minor regional languages originating from outside of Rwanda (CIA, 2012). Until recently all official government reports and education were conducted through French and Kinyarwanda. Following a national conversion from French in October 2008, all communication in schools and public administration is now obliged to be conducted through English, though adherence to this is inconsistent (Assan and Walker, 2012). Knowledge of European languages remains very limited in rural regions surrounding VNP.

3.3.3 Land-use

Land next to Volcanoes National Park is predominantly subsistence farmland, where smallholders grow a variety of legumes, tubers and cereals (Plumptre et al., 2004), in addition to the raising of a limited number of livestock under zero-grazing conditions. Average annual income has been estimated at less than $540 per household (Bush et al., 2010), while linkages to markets and alternative incomes is thought to be limited (Plumptre et al., 2004). As land pressure is so acute, little fallowing is carried out. The bimodal rainfall pattern of Rwanda, with a long and short wet season separated by a long and short dry season, along with mild year-round temperatures and high insolation (McSweeney, 2011), allow up to three crop rotations annually.

Government-driven land-use consolidation, introduced in 2008 as part Rwandan Vision 2020 goals of increasing agricultural productivity, had by 2011 resulted in over 500,000 Ha of arable land being standardized to grow priority domestic and export crops (MINAGRI, 2012b). Under this scheme, the cultivation of various key crops remains dictated by region, based on soil type, climate and market accessibility, with the objective of ensuring food security and producing export surpluses. Though participation in the scheme has been voluntary, some shared benefits are withheld from farmers who refuse to participate (MINAGRI, 2012b). This transition to monoculture is at varying stages along the boundary of VNP, though the limitations of this programme and the requirement for some flexibility in its enforcement, on ecological and socioeconomic grounds, has been recognized (MINAGRI, 2012b).

In addition, extensive regions of VNP-adjacent land are under the control of an agro-industry cash crop scheme, established as a condition of restructuring programmes and clearances in the late 20th century (Storey, 2001), and are currently under the direction of Horizon Group Sopyrwa (WTO, 2003). Land-use agreements currently state that 40% of original long-term land parcel leases from the Rwandan government must be used to cultivate pyrethrum (Chrysanthemum cinerariifolium) flowers (fig. 3.3) for the extraction and exportation of pyrethrin oils for the
pharmaceutical industry (WTO, 2003). Consequently, landholders within these concessions who are forced to grow pyrethrum have limited control of land-use, potentially creating less robust agricultural systems able to handle low frequency, but high amplitude, crop raiding events. Distribution of these regions is non-uniform across the VNP boundary.

![Figure 3.3: Example of pyrethrum cultivation as part of 10-plot parcels of VNP-adjacent farmland. Note the extensive subdivision of these plots.](image)

### 3.3.4 Land tenure

The mean self-reported domestic land holdings around VNP is 0.55 ha, or 5,000 m² (Bush et al., 2010). Though ownership of land is permitted in Rwanda, and land has traditionally been inherited through paternal lineage, legal sale or exchange of land is not permitted without the written consent of the Minister of Land. As such, renting, collaboration agreements and payment of labour through rights of use have emerged as a means of dividing use of land, in land-constrained regions such as that surrounding VNP (Plumptre et al., 2004). This has resulted in much reduced empowerment of those involved through dispute, forceful removal and threatened livelihoods (FAO, 2006), including orphans and batwa (Rose, 2005; Beswick, 2011). In response, the Rwandan government is conducting digital delineation and registration of land holdings,
giving official land deeds which allow the establishment of legal rights over holdings and provide capital for finance. This process is continuing around VNP and is to be completed by 2014, though some suspect this may lead to a reduction of local customary rights (Huggins, 2013).

The distribution of large, commercial land owners versus small mainly-subsistence land owners is not even across park-adjacent regions. Furthermore, semi-state agro-industry holds considerable sway over land tenure – and in some cases local government decisions – through unclear arrangements stemming from the forest clearances of the mid-20th century (WTO, 2003; Plumptre et al., 2004; Huggins, 2013). Independent assessment of this arrangement has not been conducted, though it is thought that some agro-industries are controlled by government subsidiaries, some of whom have close ties to the Rwandan Defence Forces (RDF) (Huggins, 2013).

### 3.3.5 Infrastructure

#### 3.3.5.1 Accessibility

Roads surrounding VNP mainly consist of narrow dirt paths following the straight lines of former forest clearances. Very limited stretches of paved road exist, which are predominantly in place to service the tourism industry, leading to hotels and gorilla trekking trail heads. Transport for local residents on non-paved roads is by foot, bicycle and lorry. Ownership of vehicular transport by those living next to VNP is extremely limited (Bush et al., 2010).

#### 3.3.5.2 Facilities

Access to potable water around VNP is limited and is determined by wealth status and distance to commercial centres (Bush et al., 2010). Domestic rainwater collection and communal water tanks are in place during the wet season, while most dry season water collection requires travel of considerable distance. Funding for larger water projects is provided by NGOs and the Government of Rwanda through tourism revenue sharing. Electricity is unavailable to the vast majority of park-adjacent residents, due to lack of infrastructure and excessive cost. This is being improved in some regions as part of larger construction projects, such as the installation of a communications mast at the top of Karisimbi Volcano. Minor domestic electrical usage is provided by batteries. Education around VNP is provided by state-funded primary and secondary schools, which provide 9 years of free education (World Bank, 2011).

Significant government investment has resulted in improvements in living conditions and healthcare (Marijnen and van der Lijn, 2012) around VNP. This has also originated from NGO investment and the sharing of tourism revenue, building and improving health centres and improving domestic conditions. For example, the Rwandan government has initiated a programme to replace all thatched roofs with iron sheeting (RoR, 2000). Though most are obliged
to cover these costs themselves, highly-marginalized citizens are provided with iron sheeting. All
VNP-adjacent residents have converted, with many including batwa benefiting from assistance.

3.3.7 Tourism involvement
Revenue generated through gorilla tourism has the potential to give lasting development and
poverty alleviation returns as recompense for forgoing use of the readily available resource VNP
presents, if distributed appropriately (Bush et al., 2010; Sandbrook and Roe, 2010). It has been
reported, however, that adjacent residents of Albertine Rift protected areas, of which VNP is one,
view tourism as being positive at a national level, but not at a local or personal level (Plumptre et
al., 2004). Since an official revenue sharing programme began in 2005, dilution among the
extremely high population density surrounding VNP has resulted in communities members
receiving the equivalent of an estimated US$0.36 each annually (Bush et al., 2010).

Employment of park-adjacent communities as porters, guides and anti-poaching rangers is
widespread, though not evenly distribution along the VNP boundary. Reported job creation
through tourism in the neighbouring Mgahinga National Park, Uganda, was similarly limited due
to its size and lack of internal roads to maintain (Adams and Infield, 2003).

3.3 Broader influences
This section outlines the national and regional influences on the study site, including national
economic and conservation policy, and political instability affecting regional conservation and
associated conflict with park-adjacent communities.

3.3.1 National concerns
Following the 1994 genocide, an influx of unilateral emergency and long-term aid and a returning
educated diaspora have resulted in significant economic development in Rwanda. The ruling
Rwandan Patriotic Front (RPF) administration aims to revolutionise the Rwandan economy
through its Vision 2020 strategy, aiming for increased investment in non-agricultural sectors such
as information and communication technology, tourism and manufacturing, as well as improved
efficiency of agriculture with a view to exportation of surpluses (RoR, 2000). This has led to annual
GDP growth of 6-8% and significantly improved healthcare and education (Marijnen and van der
Lijn, 2012). However, agricultural improvements have imposed significant restrictions on
subsistence agriculturalists, particularly those in regions already experiencing HWC. Additionally,
rural development has been found to lag behind urban industrial development resulting in a
widening wealth gap (UNDP, 2007; Huggins, 2009); an important point given that the majority (>81%) of the Rwandan population is rural (CIA, 2012).

Shortcomings in civil liberty have been identified by observers as potentially hampering development and the establishment of open democracy (Beswick, 2010), as well as a blanket acceptance of agricultural reform. This seems to be facilitated in part by what some describe as the conformism of Rwandan society (Reyntjens, 1996) and the large role played by the Rwandan Defence Forces (RDF) in government and private industry, using legislative and shadow methods to silence critics (Beswick, 2010). Though seen as necessary by the current RPF government as a means of controlling ‘genocide ideology’ and preventing a repeat of the atrocities of 1994, it is increasingly condemned by international donors and investors. At the time of writing, the stability of the RDF itself had been questioned, with several significant defections of high ranking commanders alongside implications of the latter in recent public grenade attacks (Verhoeven, 2012).

A key aim of Vision 2020 is a reduced dependency on foreign aid, which constituted almost half of the Rwandan national budget in 2008 (Bingin and Mpyisi, 2001; Campioni and Noack, 2012). It is hoped that foreign direct investment will replace this. Similarly, records of NGO work in post-genocide Rwanda are mixed, with reporting of inappropriate allocation of funding, industrial pretexts and ineffectual presences (Storey, 1997). Underperforming NGOs are now asked to leave the country, while many current NGOs have been collectivized in government-provided buildings in what some see as an effort to limit their critical engagement (Beswick, 2010). These NGOs have included conservation and development organisations.

Current Rwandan policy on conservation is aimed at maximization of tourism revenue, as a Vision 2020 objective (RoR, 2000). Recognised as part of this is the preservation of ecosystem services, including water retention, soil stability and participation in the global carbon market through payment for ecosystem services initiatives (RoR, 2010). The potential of this latter objective to alleviate rural poverty and reduce pressure on protected areas has also been highlighted (Andrew and Masozera, 2010). Though Rwandan conservation is currently restricted to three national parks, VNP is the most lucrative in terms of tourism revenue.

### 3.3.2 Regional concerns

Volcanoes National Park lies within the Albertine Rift, stretching from South Sudan and Uganda in the north, to the lower reaches of Lakes Tanganyika and Rukwa to the south (fig 3.4). As a result of its low latitude, wide altitudinal variation and high rainfall, this area contains extensive species diversity (Plumptre et al., 2007a). The role of the Albertine Rift as a Pleistocene refugium is well understood (Moreau, 1966), specifically for bird (Dowsett, 1986), plant (White, 1983) and
invertebrate diversity (e.g. Carcasson, 1964). As a result, Conservation International has designated the forests of western Rwanda as part of the Eastern Afromontane Biodiversity Hotspot (Cl, 2012), the World Wildlife Fund has identified the Albertine Rift Mountains as a Priority Ecoregion (Olson and Dinerstein, 2002) and Birdlife International have identified several regions of Rwanda as Endemic Bird Areas (Bl, 2012).

Figure 3.4: The Albertine Rift, or Western Rift Valley (orange) showing the network of forested protected areas (dark grey) and the central position of Rwanda in this. Map modified from Plumptre et al. (2007)

Furthermore, Local Ecological Footprint Tool analysis, based on species assemblage dissimilarity and vulnerability (LEFT, 2012), have identified regions of northern Rwanda (and along the margins of Volcanoes National Park specifically) as some of the most threatened and unique in eastern central Africa (fig. 3.5). As part of the northern section of the Albertine Rift, the Greater Virungas Landscape constitutes 11 interconnected protected areas, many of which exist as transboundary protected areas (TBPAs) (Plumptre et al., 2007b). Volcanoes National Park and the Virungas Massif, as a legally-defined TBPA for the Virungas, is intended to result in more cooperation in conservation and more closely aligned goals and regulations (Bronkhorst, 2005).
Recent rebel disturbances in North Kivu Province of neighbouring DRC, with potential to spark expanded conflict in adjacent Rwandan communities have emerged since the last ceasefire in 2008. United Nations and Human Rights Watch reports of the region have implicated the Rwandan government in supporting, if not orchestrating, this rebellion through the M23 rebel movement (UN, 2012). Though rules for TBPA protection during armed conflict under the Geneva Convention stipulate that care should be taken and no unnecessary and irreparable damage should be done (Bronkhorst, 2005), this has been historically disregarded in the Virungas, through continued gorilla poaching (Kalpers et al., 2003) and forest clearances as recent as 2004 (IGCP, 2004). Plumptre et al. (2007b) have identified the potentially damaging effect of this civil unrest and associated breakdowns in protected area regulation on conservation of the Albertine Rift. These pressures in the DRC may also be forcing animals into the Rwandan portion of the Virungas Massif, raising pressure on forest-based resources and potentially exacerbating crop raiding in Rwanda. In this way, potential for conflict in and around the Virungas Massif TBPA and the Rwandan portion of VNP is high, as a result of its regional conservation importance and political instability.
4. Methodology: Data Collection

4.1 Methodological framework

4.1.1 Literature review

Prior to the planning of field methods, extensive investigation was carried out into past research of human-wildlife conflict case studies globally, though focussing on developing world and tropical scenarios. This was complemented with assessments of the methodological approaches adopted. These documents were sourced in online journal repositories, library-held issues of non-digital print, holdings of the Government departments of the intended study area and through personal communications with staff of governmental and non-governmental organisations. By gaining an understanding of the findings of previous research, challenges and methodological advances, this investigation advised the design of a research question, with subordinate research objectives. Furthermore, this stage aided the development of a suite of tools to be used in order to achieve these research objectives.

4.1.2 Development of a mixed methods approach

To address the aims of this study, a description of the conflict in question, with high internal validity (Creswell 2009) was sought. Furthermore, external validity of potential findings was required to tackle varying cases of HWC globally. Like other cases of HWC on the margins of protected areas, HWC around VNP has been identified as a niche problem, predominantly affecting those living near the park boundary, living under particular factors of predisposition (Plumptre, 2002). As such, great internal validity can be obtained by directed sampling of those exposed. Conversely, the governance of park resources and mitigation efforts are often controlled externally, by government and/or private investors. Thus, in order to obtain the best possible understanding of the political ecology of HWC around VNP a combination of methods was thought more appropriate than singular quantitative or qualitative assessment alone. As Creswell and Plano Clark have asserted, observing the worldview, interpretation of results and final inferences of a study through the lens of mixed methods research, “provides a better understanding of research problems than either approach alone” (2007, p.4).

Developed in the late 1970s as a recognised methodology (Denzin, 1978), mixed methods research (MMR) has gained acceptance in both social science research and, more recently, practical conservation research (e.g. Hazzah, 2006; Austin et al., 2010; White and Ward, 2010). By combining the pragmatic and heuristic principles of qualitative research (Creswell, 2011; Teddlie
and Tashakkori, 2011), with the empirical reasoning of quantitative investigation, greater depth and breadth of understanding can be obtained (Johnson et al., 2007), through a continuum of methods, rather than a stringent binary (Creswell 2011). As Hammersley noted, this “methodological eclecticism... promises to cancel out the respective weaknesses of each method” (1996, p.167).

Though often idealized as the “third methodological movement” (Teddlie and Tashakkori, 2011, p.286) by adopting “multiple ways of seeing” problems (Greene, 2007), MMR sceptics have voiced concerns. Fundamentally, opponents question whether mixed methods presents a firmer grasp of a research problem, given the same resources for investigation (Creswell, 2011). Some view the integration of quantitative and qualitative research as incompatible, on the basis of inherent epistemological differences (though some have questioned the existence of this divide in the first place (Howe, 1988)). Others warn that MMR should only be adopted “when necessary to adequately answer the research question” (Teddlie and Tashakkori, 2011, p.295) and not only for the “idolatry of integration and coherence” (Freshwater, 2007, p.141). MMR is seen to be more expensive and time-consuming, with a tendency towards Qual-light research (Teddlie and Tashakkori, 2011). Additionally, though some studies claim to adopt MMR (e.g. Austin et al., 2010), data collection, interpretation and integration of qualitative findings remains supplemental and subordinate to quantitative methods. Though rarely acknowledged, Sandelowski et al. (2009) note that quantitative measurement is often dependent upon qualitative judgements and context. More cutting criticisms are directed at the researcher him/herself, including Denzin’s observation that having minimal competence in both schools of thought is “superficial, perhaps even unworkable” (2008, p.322).

Given the complex political ecology of human-wildlife conflict around Volcanoes National Park, it was thought that mixed methods would more effectively address the research objectives of this study and would yield greater internal and external validity than could either quantitative or qualitative approaches alone.

4.1.3 Study design

Validation of accounts given was key and would be achieved through triangulation with subsequent alternative methods (Denzin, 1978; Knodel, 1993; Krueger, 1994; Wilde, 2001; Sandbrook and Adams, 2012), and through blind retro-translation of transcripts where applicable. This would be in concert with reflexive thought; as Krueger asserts “validity depends not only on the procedures used but also on context” (1994, p.31). The issue of perceptive distance has been recognised as a problem in qualitative social science, which would be addressed here through the
researcher being present during data collection (Knodel, 1993). Though potentially introducing bias, the benefits of being present were thought to offset this.

Having investigated MMR theory (Howe, 1988; Freshwater, 2007; Creswell, 2009; Charmaz, 2011; Creswell, 2011; Teddlie and Tashakkori, 2011) and strategies utilised in other field studies (Austin et al., 2010; Sandbrook and Adams, 2012), the following investigative framework, based on a nested mixed methods design, was adopted.

**Figure 4.1:** The mixed methods nested framework used in this study.

In order to address the research questions posed in this study and obtain a well-validated and substantiated description of HWC around VNP and the stakeholders involved, concurrent triangulation (Creswell, 2009) was adopted using a combination of quantitative and qualitative approaches (fig. 4.1). This constituted the use of qualitative investigation (focus groups and administered surveys) in addition to empirical measurement. Though this format has been shown to result in discrepancies of data comparison (Creswell and Plano Clark, 2007), it was hoped that this would be offset by yielding a greater understanding of the complex issue. The qualitative phase of this investigation was designed under a sequential exploratory framework, whereby focus groups advised the structure and execution of in-depth investigation at the household level. The 3-phase development and implementation plan, forwarded by Creswell and Plano Clark (2007), was adopted here (fig. 4.1). It was furthermore hoped to investigate both quantitative measures of HWC and its impact, and qualitatively assess attitudes to wildlife, governance of natural resources and tourism revenue sharing around VNP. This took the form of a concurrent embedded model, with qualitative enquiry (open-ended questioning and discussion) nested
within quantitative investigation of HWC and its effects. It was hoped that the combination of these embedded analyses would yield an “overall composite assessment of the problem” (Creswell, 2009, p.214), with a view to advising a more effective solution.

This sequential template has been followed in other studies of HWC (Blomley et al., 2010), particularly when community participation in decision-making and planning is sought (Beck, 2010; Blomley et al., 2010), as in Integrated Conservation and Development Projects (Johanneson, 2004; Laudati, 2010). As Krueger notes, this sequential model helps the researcher to “learn the vocabulary and discover the thinking pattern of the target audience” (1994, p.29). Furthermore, it may highlight potential problems and sensitivities of future investigative tools, allowing modifications to be made before data are lost (Krueger, 1994; Spash, 2000; Dupain et al., 2010).

The following section outlines the discrete methodologies adopted to address the five research questions of this study under the structure outlined above, while Table 4.1 below outlines the mixed methods used in addressing the five research questions of this study.

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4.1.3.1 Focus groups

By creating a relaxed environment, free from perceived elites, judgement and fear of repercussions, focus groups aim to “nurture different perceptions and points of view, without pressuring participants to vote, plan or reach consensus” (Krueger, 1994, p.6). Though this runs the risk of giving more dominant members of the group disproportionate influence and may give a stage to more extreme members of a society, collective discussions may also allow previously inexpressive members to voice opinions. Through a series of planned topics of conversation, activities and practiced probing of common themes it is thought a much more comprehensive understanding of a community (and the problems they face) can be built (Wilde, 2001). Although focus groups are not intended to reach consensus among a community, they provide a useful mechanism for elucidating as much information as possible, especially when complemented with further individual interviews (Morgan and Krueger, 1993).
As a means of gaining this initial comprehensive understanding towards answering all research questions, and as a hypothesis synthesis tool (Puchta and Potter, 2004; Priston, 2008), an investigative focus group phase was planned. This was decided in order to establish an understanding of key features of conflict around VNP, especially when the differences of opinion between potential participants and decision makers are great (Morgan and Krueger, 1993). It was hoped this initial flexibility would yield data of high internal validity with strong regional specificity (Creswell, 2009), a key goal of this study, as preliminary investigations pointed towards the presence of significant demographic and spatial variation in crop raiding and drivers of this conflict.

4.1.3.2 Household survey transects
In order to establish the current extent and magnitude of HWC around VNP (RO1), perceptions of this (RO3) and its likely determinants (RO2), in depth household survey transects were chosen to explore predetermined quantitative, spatiotemporal variation in factors such as levels of perceived raiding, crops grown, socioeconomic status of households and length of time living in the area. In addition, this provided an opportunity to assess current mitigation (RO4) and the perceived impact exacted by this on local communities (RO1), the tourism industry and conservation efforts (RO3). Finally, individual household administered surveys provided a method of assessing the acceptability of an insurance scheme to buffer against losses due to raiding (RO5). Under time and resource limitations a sampled set of in-depth surveys, controlled for location, thus allowed for combined analyses of varying quantitative and qualitative questions simultaneously. In addition to addressing pre-prescribed issues identified from other examples of human-wildlife conflict in the literature, this stage of the study design allowed for exploration of issues anecdotally raised in the focus group and preliminary investigation phases of this study.

4.1.3.3 Contingent valuation
As a means of assessing the potential for a locally-run insurance scheme (RO5), a valuation methodology was required. Integration with household surveys allowed for in-person valuation questioning, thus offering greater accuracy and allowed the use of visual narrative aids (Arrow et al., 1993; Boxall and Beckley, 2002). In order to measure the value of this non-market good (protection against crop raiding) a non-market valuation technique was required to obtain the maximum amount willing to be paid by VNP-adjacent farmers to guarantee against possible loss through crop raiding. As such a Willingness to Pay (WTP) template was adopted (Boxall and Beckley, 2002; Hanley and Barbier, 2009). Critics of this valuation technique, however, have claimed that the process could essentially be seen as “gestures in a political process” (Vadnjal and O’connor, 1994) or the “purchase of moral satisfaction” (Kahneman and Knetsch, 1992). If some of these strategic biases were present, the stated WTP begins to diverge from actual worth. Thus,
in order to measure the WTP of farmers into a locally-run insurance scheme, a value-elicitation device was required which reduced strategic biases and vested interests as much as possible. For this, contingent valuation (CV) was chosen as an appropriate valuation technique (Hanley et al., 2001).

By establishing a plausible theoretical scenario of change, centred on a theoretical market, CV aims to obtain a figure which, though not absolute or corresponding to monetary value, yields varying degrees in acceptance of the proposed insurance scheme. Recent advances in valuation questions (the ‘stated-preference’) have led to dichotomous choice (DC) being favoured (Boxall and Beckley, 2002). This option is also thought to be more statistically robust than open-ended designs (Poe et al., 2002). Additionally, in order to further improve accuracy and statistical functionality a double-bounded pair of valuation questions is now commonly used (Hanley and Barbier, 2009) and was thus selected for this exercise. In order to avoid incentive incompatibility, or ‘free-riding’, a provision point mechanism (PPM) has been developed, whereby a minimum local aggregate from an unknown number of respondents is required in order for the public good to be realised, thus reducing zero and protest bids (Poe et al., 2002). In order to accurately value an insurance scheme in this study, a PPM was also adopted.

Though WTP exercises have been conducted to varying degrees of success in the developed world (e.g. Banzhaf et al., 2006; Becker et al., 2007), challenges have emerged when assessing agricultural systems in developing economies (e.g. Whittington et al., 1993). These include ill-defined property rights, limited autonomy over livelihoods, cultural differences on local scales and exclusively subsistence household production (Boxall and Beckley, 2002; Ressurreição et al., 2012). Further to this, the benefits associated with some recent developing world valuation exercises accrue to the developed world (e.g. the UN Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD)). Awareness must also be held in questionnaire composition of differing priority hierarchies, collective-based decision making and payment vehicle plausibility (Boxall and Beckley, 2002). It was hoped that focus groups would play a prominent role in adapting this procedure, by advising on the most socially-acceptable bid vehicle, information set and question format (Hanley et al., 2001).

4.1.3.4 Boundary survey
As a means of ascertaining the extent of effective mitigation around VNP (RO4), personal observations were required of the quality and extent of wall, trench or other forms of physical barrier. In order to accurately assess this given resource constraints, a sampled approach was adopted. Characteristics would be measured at 200m intervals along the boundary. Sampling the 65km boundary at this interval would yield a data set of circa 300 records, which would still adequately represent the wall quality but would not be cumbersomely large. In addition to
continuous data, event data would also be recorded, noting the locations of ravines, significant (>1m) gaps in defences, areas of clear human use and locations of guard structures. These data would be georeferenced for intended use as part of analyses into spatial susceptibility to raiding.

### 4.1.3.5 Monitoring

In order to obtain quantifiable measurements of the extent and magnitude of HWC along the margins of VNP (RO1), accurate and systematically-recorded monitoring accounts of crop raiding events experienced by exposed farmers were required. These measures of raiding would then be compared to perceived levels expressed in focus group and administered survey phases, to address any observed discrepancy in reported versus actual HWC. Combining these monitoring data with boundary survey data would ascertain the effectiveness of current mitigation strategies (RO4), while using these data to construct a multivariate model best explaining the spatiotemporal variation in conflict would further explain key determinants of this conflict (RO2). Finally, by measuring damage done insights could be gained on the socio-economic impact of HWC (RO1).

Though detailed records of raiding have been obtained in other studies, involving the calculation of crop preference and susceptibility indices (Kagoro-Rugunda, 2004), it was felt that the resources (time, money and knowledge) required to obtain these detailed sampled metrics would not pragmatically contribute to a mixed methods assessment of HWC. Similarly, sampling carried out using randomly distributed quadrats in other studies was found to underestimate raiding intensity (Hill, 2000). In the case of this study, it was hoped that revision of monitoring would allow detailed spatial assessment to be carried out, identification of the most important explanatory variables and would advise site specific actions based on this.

### 4.2 Preliminary investigations

In order to gain an initial understanding of conflict around VNP, its drivers and consequences, and the feasibility of planned methodologies, a preliminary investigation was carried out prior to executing the extended methods of this project. This involved the actions which follow.

#### 4.2.2 Observational boundary walks

Six informal observational walks were made towards the edge of the park from January to March 2012, intended to ascertain the extent and condition of forest boundary defences, the mitigation measures implemented by the local communities and to obtain a general picture of cropping systems around the park. Furthermore, informal opportunistic interviews were conducted with residents present, on days when a translator was available. Results from these walks advised
several methodological changes, including modes of recruiting focus group participants and questionnaire protocol.

4.2.3 Key informant / stakeholder investigation

Recruited on an opportunistic basis, these were conducted throughout the period spanning January – March 2011 and during initial planning stages of the extended field period, in September 2011. This included informal discussions with representatives from key international NGOs active in the region, representatives from VNP and members of local community groups (Table 4.2). In addition to providing insights on current conflict issues and mitigation strategies, this stage also allowed for organisation of practical arrangements, including identification of research assistants and organisation of transportation and accommodation for the longer period of fieldwork. The investigative phase of the project also included attendance at and organisation of public and private gatherings, outlined in Table 4.3.

Table 4.2: List of key informants and stakeholders interviewed as part of preliminary investigations

<table>
<thead>
<tr>
<th>Informant / Stakeholder</th>
<th>Organisation &amp; position</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Katie Fawcett</td>
<td>DFGFI – Former Director</td>
<td>VNP conservation, community initiatives, logistical advice</td>
</tr>
<tr>
<td>Dr. Glenn Bush</td>
<td>Woods Hole Research Centre &amp; consultant economic researcher</td>
<td>Contingent valuation, interview and survey techniques, logistical advice</td>
</tr>
<tr>
<td>Giuseppe Daconto</td>
<td>CARE International– Regional Programme Coordinator of EEGL Project</td>
<td>VNP microfinance, the cooperative movement, NGO operation</td>
</tr>
<tr>
<td>Vicki Chambers</td>
<td>Overseas Development Initiative</td>
<td>VNP resource conflict, water governance, tourism industry</td>
</tr>
<tr>
<td>'John'</td>
<td>DFGFI - Head tracker &amp; land-owner</td>
<td>Cooperatives, land tenure, revenue sharing</td>
</tr>
<tr>
<td>Stacy Rosenbaum</td>
<td>DFGFI - Doctoral researcher</td>
<td>Gorilla distribution &amp; feeding ecology</td>
</tr>
<tr>
<td>Dr. Winnie Eckhart</td>
<td>DFGFI - Postdoctoral researcher</td>
<td>Gorilla distribution &amp; feeding ecology</td>
</tr>
<tr>
<td>Prosper Uwingeli</td>
<td>RDB - VNP Chief Park Warden</td>
<td>VNP operations, research permission, logistical support</td>
</tr>
<tr>
<td>Janvier Kwizera</td>
<td>RDB - VNP Community Conservation Warden</td>
<td>Community conservation projects, current monitoring, revenue sharing, cooperatives</td>
</tr>
<tr>
<td>Oreste Nydayisabo</td>
<td>RDB - VNP Community Conservation Warden</td>
<td>Community Conservation projects, current monitoring</td>
</tr>
</tbody>
</table>
Abel Musana | RDB - VNP Monitoring and Spatial Analyst | Spatial data, current monitoring
Krista Isaacs | RAB - Doctoral researcher | Traditional agriculture, intercropping
Isaac Nshimiyamana | CARE International enumerator & local resident | Social structure, governance hierarchy, logistical advice
Elias Nyandwi | CGIS – Environmental and Natural Resources Management Unit | Spatial data (demography, administrative boundaries, climate)
Deo Tuyisingize | DFGFI - Biodiversity Programme Coordinator | VNP large mammal distribution, habitat suitability
Misc. local farmers | Various locations along VNP boundary | Farming strategy, HWC, agro-industry

Table 4.3: Public and private meetings attended or organised as part of preliminary investigations

<table>
<thead>
<tr>
<th>Meeting and date</th>
<th>Attendants</th>
<th>Topic/Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iby'Iwacu Cooperatives meeting - 27/01/11</td>
<td>Community Conservation Teams, cell leaders, law enforcement representatives</td>
<td>HWC problems, cooperative establishment, my intended research</td>
</tr>
<tr>
<td>Kabatwa Sector Office meeting - 08/02/11</td>
<td>Military commanders, sector executive secretary, Cell leaders and cooperative representatives</td>
<td>Karisimbi Antenna Project, use of forest</td>
</tr>
<tr>
<td>Kabatwa Village meeting - 08/02/11</td>
<td>Military commanders, sector executive secretary, cell leaders and cooperative representatives</td>
<td>Karisimbi Antenna Project, revenue sharing, use of forest resources</td>
</tr>
<tr>
<td>Trial focus groups - 23-24/02/11</td>
<td>MSc. Environment and Development students, selected community members, cell leader</td>
<td>HWC, farming systems, livelihood limitations</td>
</tr>
<tr>
<td>Bugeshi Village meeting - 13/09/11</td>
<td>RDB representatives, cell and sectors leaders, cooperative leaders</td>
<td>Crop raiding, defence construction, revenue sharing, cooperatives</td>
</tr>
<tr>
<td>Community Conservation Teams Refresher Course - 20-21/09/11</td>
<td>RDB representatives, Community Conservation Teams, IGCP representative</td>
<td>Monitoring of forest use, law enforcement, my intended research</td>
</tr>
<tr>
<td>Joint Action Development Forum for Tourism and Conservation - 22/09/11</td>
<td>Chief Park Warden, Board of Joint Action Forum, RDB representatives, various hoteliers, cooperative leaders</td>
<td>Regional ecotourism, ‘harmonisation’ of local industries, batwa, homeless children</td>
</tr>
</tbody>
</table>

4.2.4 Informal focus groups

A total of five trial focus groups were held prior to collecting primary data. Three trial focus groups were conducted with members of forest-adjacent communities in February 2011. The
form at of these focus groups varied, from a structured schedule of investigative topics to more informal discussions largely led by the local individuals. Focus group tools outlined in the SEAGA Guidelines for Participatory Rural Appraisal (Wilde, 2001) were tested as part of these. Several locations were used, from group discussions in farmland to organised meetings in administrative offices. Varying combinations of attendants were trialled in terms of the presence or absence of local leaders, mixed versus single-gender, the presence or absence of children and varied combinations of socioeconomic status. Through this exercise, appropriate focus group tools were identified, in addition to the realisation that gender-specific focus groups would yield more open discussion, as found in previous studies (Hazzah, 2006; Steel and Yoko, 2010). The presence of local leaders was found to influence levels of discussion and so was limited in future focus groups, though in some instances it was agreed that in order to maintain local support and quell suspicion local leaders would be permitted to attend. A provisional focus group schedule was developed from these trials.

An additional two trials were held in non-sample communities using the intended schedule of activities. This included testing of a sampling method using administrative lists of residents based on categories of socioeconomic status assigned by local government, as utilised in previous socioeconomic studies. This was deemed inappropriate as most residents were either unaware of the ranking system or disagreed with the rank that had been assigned to their household. In particular it was felt that not all residents would be accounted for on these lists, while it was thought that using these local lists may allow local officials to influence sampling. Future selection of focus group participants was thus based on the appearance of respondents' dwellings and compounds.

Issues concerning flow of conversation and expression of opinion, independent voting (for ranking exercises), the presence of children in focus groups and the attendance of local elites emerged and were addressed where possible. Additionally, the presence of several Batwa community members at initial trials highlighted the potential tension this could cause in future groups. As such, the facilitator was encouraged to actively engage with these during focus groups, as trials had revealed that Batwa remained marginalised in groups of non-Batwa. Levels of discussion were low, with assumed fear of expression apparent. These trials allowed the facilitator to develop informal conversation starters/propagators. The timing of some trials was excessive and attention of some participants began to wane. As such, less priority was placed on some elements of the schedule and the facilitator was requested to move conversation on when he deemed this necessary. Modifications in these regards led to the development of a final focus group schedule (Appendix A).
4.2.5 Assessment of park monitoring

Initial consultation was conducted with the Community Conservation Wardens of VNP to ascertain the form and function of existing monitoring efforts employed. Current efforts involved the non-systematic collection of HWC event data, some of which involved geo-location. Significant limitations were identified in this system, though RDB were keen to improve on this. From September to December 2011 consultation was carried out towards establishing systematic and comprehensive monitoring of HWC around VNP. Shortcomings were identified in the current system, from layout of collection sheets, training of data collectors and the areas being monitored. Existing data sheets were cluttered (leading to largely illegible entries) and included the names and personal details of those affected. These collection sheets were akin to legal documents, including institutional crests, disclaimers, and official signatures. It was agreed that this should be modified to a less intimidating document, to encourage honest participation of farmers. Secondly, previous recording was solely conducted in a pre-identified ‘Critical Zone’, based around areas of high gorilla density. The justification behind this zone’s demarcation was unclear and seemed aimed at generating positive tourist opinion. A collective decision was thus reached to establish a data collection programme based on the previously-selected sample sectors, at minimum. Given availability of resources, expertise and motivation it was agreed that monitoring could be expanded to cover all park-adjacent sectors. Improvements in the training and supervision of data collectors were identified as being vital to future monitoring plans.

Preliminary public meetings revealed that responsibility for forest resources and their conservation was actively instilled externally by VNP management and local leadership. Thus, the need for local involvement in mitigation of HWC was identified under the assumption that generating ownership of the task would increase responsibility for conservation through self-motivated action.

4.3 Background to field data collection

4.3.1 Positionality and reflexivity

As defined by Lau (2004, p. 65) “positionality involves taking into account the factors which contribute to the shaping of a person’s identity, perspectives, worldviews and angles of perception”. These could include gender, age, race, nationality, religion, education, wealth status, training, travels and experiences. In order to begin to account for these potential disparities, these factors must first be acknowledged, allowing their integration into analytical and interpretive phases. I was aware that I was Caucasian, foreign, educated, non-religious, younger
than most farmers, had travelled extensively and was more affluent than most. This was addressed through careful consideration of previous literature, the pragmatic limitations of the intended study site and a reflection of the researchers own motives and limitations. In this case, the desire to obtain an answer to a complex HWC case study was combined with the will to gather meaningful and novel results as part of a PhD study process. Choosing a research assistant from a rural background, with experience of agricultural work, was highly beneficial, in addition to my own positionality of having grown up in a rural area and having experience of agricultural work. Indeed, some authors have advocated for being able to “speak the language of rural communities” (Farmer et al., 2012, p.2), a concept closely linked to Bourdieu’s theory of habitus, whereby an understanding of the “rules of the game” enriches collected data (Bourdieu, 1990, p.13). Finally, as in other sociological investigations of African protected areas (Sandbrook and Adams, 2012), it was emphasised throughout all interactions that we were not employed by VNP management or any other stakeholders of VNP.

Reflexivity was also adopted to address these concerns of positionality, using introspection to evaluate the researcher’s “partial perspectives on the world... from specific locations, embodied and particular, and never innocent” (Rose, 1997, p.308). While conducting this study, interactions with participants were reflected upon in an effort to improve the validity of conversations to follow, in addition to reflecting upon the strengths and weaknesses of individual components of the methodology. For example, following consideration of some focus group activities and the resultant alienation of participants, these were modified or removed.

4.3.2 Language

All official public meetings, government documentation and education are obliged to be conducted through either English or Kinyarwanda. However, initial observation of VNP meetings and University interaction, in addition to informal conversation with representatives of other sectors in Rwanda (including education and NGO activity) revealed that most meetings were still conducted either in Kinyarwanda or French, with the former being preferred in northern and more rural parts of the country. According to those consulted in preliminary investigations, the switch from a Francophone to Anglophone system had led to considerable difficulty in communication and in some instances this obligation was being disregarded. Given that my level of French was conversational, and I had little or no initial knowledge of Kinyarwanda, a research assistant with knowledge of both these languages was required. Furthermore, it was felt that the conveyance of nuanced meaning at local and individual meetings was limited, notwithstanding issues of positionality. Thus a research assistant who was locally known and respected was recruited with in-depth knowledge of the area. A period of trust-building was allowed for before beginning data collection with this RA, to maximise the fidelity and conceptual equivalence (Larkin
et al., 2007; Müller, 2007) of translated statements. As fieldwork progressed, improvements were made in my own knowledge of Kinyarwanda, ultimately allowing for participation (and sometimes intervention) in the administered surveys of later stages. In some instances this led to a reduction in over-generalisation of answers given.

4.3.5 Cultural context

Knowledge of appropriate cultural sensitivities is essential (Morgan and Krueger, 1993). Though the terms ‘hutu’ and ‘tutsi’ have been outlawed in Rwanda (RoR, 1999) (excluding reference to the Genocide Against the Tutsi), informal discussions prior to the extended period of fieldwork revealed that levels of division remained between ‘people from the south’ (tutsi) and ‘people from the north’ (hutu). Preliminary discussions with local farmers and research assistants revealed that most members of VNP management staff were not local, with a baseline level of distrust as a result. This was a key consideration in maintaining the support of VNP management, while retaining the trust of park-adjacent communities. As such, great efforts were made to outline that I was not working for, but rather with, VNP management. Furthermore, referring to the batwa required the use of the legally-approved term “historically-marginalised people”, though most still used the term batwa. Throughout the study, adaptability was required to avoid offending or disempowering any of these cultural sub-groupings, through the use of culturally-unacceptable or legally-outlawed labels. Being aware of my positionality, strategies were deployed on a case-by-case basis to avoid these sensitive issues.

4.3.3 Ethics

4.3.3.1 Focus groups

The composition and execution of focus groups in this study presented several ethical considerations. Anonymity of attendees was maintained where possible. This was unavoidable under certain circumstances, such as selection of a respondent from a group of workers, or referral by third party. Choice of non-participation was reserved by the respondent at all times and it was made clear that no obligation existed, nor would benefit be foregone through refusal. Efforts were made to create a safe and relaxed environment for participation. For example, attendance at these meetings was limited to those invited, with local leaders or law enforcement officials being asked to remain outside, where acceptable. In this way, political and/or social ramifications for participation were minimised (Morgan and Krueger, 1993). This also has the effect of dispelling local perceptions that “only the educated elite had the technical skills to participate”, as observed in similar studies (Sandbrook and Adams, 2012, p.297). Payment for attendance was ill-advised (Wilde, 2001), as it was felt that this could create a basis for participation in subsequent stages of this investigation and other future studies. Finally, efforts
were made to ensure that all economic, cultural and social classes were allowed to speak on equal footing, while also respecting existing cultural and social hierarchies and sensitivities (Morgan and Krueger, 1993). Although confidentiality of all data collected for analyses was guaranteed, little control was held over third party disclosure of information (Morgan and Krueger, 1993), beyond requesting that all confidential opinions expressed within the confines of the groups remained so. As facilitators and the principle investigator were aware of the potential, through empowering expression, to falsely promise action, assurances were made that direct action could not be guaranteed nor expected, though recommendations would be made.

4.3.3.2 Administered Surveys

In administering surveys, community members were given freedom of participation, anonymity and the right to refuse the use of a digital recorder. Though requests were made by VNP management to record names and phone numbers of those spoken to, this was declined on the basis of possibly restricting expression of sensitive information and consequent political repercussions. All participants were assured that, though personal and financial data were being held for analyses, these would not be directly shared with local government or other participants. Finally, disturbance to working days was kept to a minimum, either by allowing them to answer questions while continuing to work in fields, or by assisting with their work.

4.3.4 Logistics

Public transport services and infrastructure were regular, safe and well-maintained throughout the country. However, accessing areas bordering VNP was more problematic. A single paved road exists within 1km of the park boundary despite maps displaying a significant network of roads around the park. All other roads were unpaved, narrow and affected by seasonal flooding resulting in extensive damage. Though some of these were accessible by large trucks used to transport produce, most were only accessible by foot, bicycle or motorbike. The costs of NGO-supported logistical support were deemed excessive and relied on the availability of drivers, guides and research assistants. Furthermore, following initial investigation of NGO activities in park-adjacent communities it was thought that travelling to villages in large vehicles would compromise positionality and thus the participation and honesty of respondents. Weather conditions appeared to hamper most large transport, with roads becoming muddy and impassable. A motorbike was thus used for the duration of fieldwork. Being a more common form of transport in Rwanda, it was less intrusive and did not attract crowds when visiting rural areas.

As the boundary walk involved residing in communities bordering the park, it would be conducted following completion of focus group and interview phases, when relationships with local people had been firmly established and navigational reference points had been stored on the GPS unit.
4.3.6 Trust building

Key to maintaining trust is the perceived impartiality of the researchers, which was achieved through a combination of initial assertion of this fact during focus groups and household interviews, coupled with demonstrating respect for the opinions, worldviews and cultural sensitivities of participants (Morgan and Krueger, 1993). This point was particularly important in politically sensitive regions, such as northern Rwanda, and when dealing with potentially-divisive topics such as land-use and lack of autonomy. Trust in the facilitator, in addition to assurances of mutual understanding of topics to be addressed and tools to be used, was vitally important. It was also hoped that this would improve honesty and participation.

Efforts were made to establish a relationship of trust with local military commanders, using VNP management as intermediaries. Through attendance at initial meetings with National Park management, military commanders and local government representatives, access to park-adjacent communities was granted, given that permissions of specific cell and sector leaders were also obtained. It was known, however, that some of these leaders were non-local ex-military commanders and, as such, were less trusted locally. Interaction with these was kept to the minimum of granting research permission. Negotiation with voluntary members of local defence was also required for access to some areas and communities. Given my position as a foreign researcher, and the awareness that I may be scrutinising the operation of VNP and land tenure of adjacent farmland, suspicion of my intentions was potentially high (e.g. Hockings and Humle, 2009). As part of efforts to reduce this, efforts were made to informally socialise with National Park officials and arrange meetings for neutral venues. Similarly, a large network of local contacts along the margins of VNP served to ease relations with local defence volunteers.

4.4 Field data collection methods – primary data

4.4.1 Sample selection

A sampled approach was adopted for this study, given the length of the margin of Volcanoes National Park, the number of people potentially inhabiting this area and its relative inaccessibility as preliminary investigations had revealed. The following section outlines the steps taken in establishing a representative sample.

4.4.1.1 Sector sampling

Following previous consultation with VNP officials and NGO staff, it was decided to focus evaluation efforts in equally-spaced sectors along the forest edge, with a view to collecting data in
areas of high HWC and those areas with less documented conflict. Furthermore, it was hoped to assess areas with emerging HWC, as preliminary investigation of communities in these areas and VNP management had highlighted this. The 12 sectors bordering VNP each possess varying lengths of National Park margin. Given time and resource constraints, sampling each of these sectors was unfeasible; yet choosing every second sector fails to account for size of sector and length of VNP border. Thus, sampling areas were equally spaced along the margin of the park, taking the sector at which these intervals occurred as sample sectors. This protocol is outlined below.

Through geographical information systems (GIS) mapping and overlay in Arc-Map v10 (ESRI, Redlands, CA) as well as consultation with VNP management and NGO biologists, this preliminary selection was then adjusted through multi-criteria analysis using the following considerations.

**Faunal distribution in VNP**
This information was based on sightings recorded on Ranger-based monitoring from RDB and records of DFGFI. In the Rwandan portion of the Virungas Massif, distribution of gorilla groups tended towards the central area, in the saddle between the three volcanoes of Sabyinyo, Gahunga and Muhabura to the east and Biseke and Karisimbi volcanoes to the west (fig. 4.2). Though this was known to vary based on seasonal and super-seasonal migratory patterns (Robbins et al., 2001; Robbins and McNeilage, 2003), the majority of gorilla sightings outside VNP were reported in this central region. Golden monkey distribution was predominantly to the west, around the slopes of Karisimbi volcano, where most golden monkey raiding has been historically reported. Buffalo distribution was unknown, though was thought to be relatively homogeneous throughout VNP with the exception of higher altitudes and the western extremities of VNP (Owiunji et al., 2005). Distributions of smaller raiding mammals such as porcupine and duiker were unknown. Previous remotely-sensed habitat mapping exercises (Kayijamahe, 2008) have identified significant variation in vegetation near the boundary of VNP (fig. 4.2), though the ability of this to accurately predict the presence of potentially-raiding species is unclear.

**Historical raiding**
The Critical Zone has been the focus of increased mitigation efforts and limited collection of non-empirical, sporadic crop raiding data in recent years. Given its limited nature, it was felt that this did not accurately represent HWC. Anecdotal accounts during preliminary analysis and through consultation with VNP management identified emerging HWC in regions to the west and east, bordering regions of the Virungas Massif lying in other countries (DRC to the west and Uganda to the east). As such, revised sampling was aimed at capturing this variability.
**Topographical variation**

Accounts given in preliminary investigations and findings of other studies suggest that certain topographical factors may influence exposure to, and intensity of, raiding. Steeper slopes tend to lead to poorly maintained defences (walls and ditches) and changes in farming practices. Shallower slopes provide easier construction of defences but also allows for more intensive agriculture and easier transit by raiding animals (especially large mammals). Topographical variation along the VNP boundary is substantial. Areas closer to DRC and in the central saddle region are considerably flatter than those at the bases of volcanoes, and are consequently highly cultivated. Altitude, dictating rainfall and temperature, varies between 2,200 -3,000 m along the VNP margin. Sample sectors were chosen which represented this topographical variation.

**Accessibility and safety**

Sampling required consideration of accessibility and safety, including the condition and presence of roads and my level of off-road driving expertise. Additionally, some less-accessible sectors were excluded from the sample due to inaccessibility and concerns over the potential presence of rebel troops from DRC.
**Demographic variation**

Prior socioeconomic surveys of VNP-adjacent communities have shown variations in population densities and socioeconomic standing along the park boundary (Bush *et al.*, 2010). Changes in administrative boundaries and nomenclature since surveys of 2009 complicate this, as does the recent movement of dwellings away from the park boundary. As a potential determinant of conflict, obtaining a representative sample of this variability was important. Furthermore, several sectors were known to support communities of Batwa, which preliminary investigation had revealed may have differing opinions of conflict and VNP conservation.

**Land tenure**

Preliminary investigations of agricultural systems and land-use suggested that differences in control and ownership of land existed across the park-adjacent sectors. Selected sample sectors were modified to obtain a representation of this variability.

Digital layers representing the above ecological, topographical and socioeconomic variability (where available) were overlaid in Arc-Map. From this a revised set of sample sectors was compiled through consultation with VNP management and local research assistants (fig. 4.3).

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**Figure 4.3:** Sectors of northern Rwanda adjacent to Volcanoes National Park, with those sampled in grey.
4.4.1.2 Focus group participants

The composition of focus groups largely dictates the validity of findings, depending on the desired outcome and sample population. This can range from gender specificity (Hazzah, 2006; Steel and Yoko, 2010) and village specificity (Steel and Yoko, 2010) to broadly mixed groups of both genders, while variability in backgrounds and expected attitudes towards concepts has been advised (Knodel, 1993). For this study, it was intended to conduct focus groups with a random selection of residents within each sample sector, concentrating particularly on those constituent cells bordering the park. Due to logistical limitations, selection of one cell within each sample sector was made in conjunction with VNP Community Conservation Wardens, considering proximity to the park and an even distribution spatially (fig. 4.4). Intragroup homogeneity was improved through this selection strategy (Knodel, 1993).

Figure 4.4: Sample cells used in focus group sampling, with location of trial and sample focus groups overlaid.

Recruitment within these park-adjacent cells was carried out using a random stratified approach. Thus, the weighting of opinions based on the proportions of demographics within these communities would be reflected in the data collected. This was carried out under the following criteria:
1. Socioeconomic status
Commonly used as a break variable in focus groups analyses (Knodel, 1993), this was measured by the presence of defined household characteristics, including house build type, the presence of an outside cooking hut, a fence around a housing property and ownership of livestock. Though used as part of NGO sampling processes, preliminary investigations raised questions over pre-existing government assigned socioeconomic category lists, while informal discussions with farmers revealed that most were either unaware of this categorisation or did not agree with their assigned status.

2. Distance to the park
Participants living at varying distances from the VNP boundary were recruited for each focus group, as distance to a protected area often dictates the intensity of raiding and may influence perception of raiding and conservation efforts.

3. Gender
Preliminary investigations showed that female participants were much less involved in the presence of husbands or local elites and that a disproportionate amount of field labour is carried out by women. As such, equal recruitment of male and female participants was made in order to carry out gender-specific focus groups for each sample sector.

Based on these three criteria, participants were selected along walks within VNP-adjacent cells in each sample sector, obtaining 6 male and 6 female community members spanning as wide a spectrum of the above factors as possible. Permission to conduct both the sampling of participants and the focus groups themselves was obtained in advance through RDB contacting the relevant sector Executive Secretary. Cell leaders were subsequently informed of our presence, coupled with an informal meeting on the day of sampling, though they were requested not to attend the sampling itself.

4.4.1.2 Household survey transects
Household surveys were conducted on the same sampled sector basis used for the focus groups. It was hoped that by using these sectors, under the same assumptions of variability outlined above, all conceivable sects of the population in question would be included in the sample. As an important factor in explaining exposure to crop raiding (Hill, 1997; Naughton-Treves, 1998; Plumptre, 2002; Tweheyo et al., 2005), distance to a protected area was captured through the use of perpendicular transects (fig. 4.5). Previous studies have found that primates rarely venture beyond 500m from protected areas (Hill, 2000) while the majority of buffalo raiding around VNP has previously been recorded within 1km of the park boundary (Plumptre, 2002). Furthermore, using a distance in excess of this would bring transects close to main roads and large towns, where forest-dwelling animals are rarely seen. Using Arc-Map, 1km transects were geo-located at
1km intervals along a line demarcating 1km distance from the forest edge (generated using the Buffer Spatial Analysis tool) within the sample sectors. Instead of using the VNP boundary itself, this buffer approach was used to account for curvature of the boundary and possible overlap of transects. The GPS coordinates of beginning- and end-points were exported to a Garmin E-trex® handheld GPS unit.

Along each transect, a respondent would be located at 200m intervals, within a 100m radius of each point (fig. 4.5). Initial trials revealed several issues with this sampling approach. Firstly, availability of households in each distance window was found to be limited. Recent government policy (RoR, 2000) to move houses from the forest edge to aggregated settlements meant that the majority of forest-adjacent farmland was without dwellings. As a result, sampling was modified to opportunistically obtaining those either working in fields or in dwellings where available. Those not in homes were then asked to describe their home or point to it. In order to maintain the distance element of sampling, the transect approach was retained. Trials of this modified collection approach was expected to yield 5 administered surveys per transect.

![Figure 4.5: Perpendicular survey transects protocol used in household sampling.](image)

The second concern was the absence of large landowners who may not work on their land but who are, nevertheless, exposed to loss due to crop raiding. This was resolved in trial transects through asking adjacent farmers for contact details (akin to snowball sampling (Goodman, 1961)) and conducting administered surveys at a convenient time and place. In this way, the views of this
important section of park-adjacent farmers were not overlooked. Finally, conducting transects in a direction leading away from the park edge (i.e. point A – point B in Figure 4.5) was found to be too late in the day to obtain respondents. As such, this was reversed, traversing B to A instead.

Following these revisions, an adequate number of respondents were obtained in, or close to, the land they farm and/or own, allowing accurate GPS location of susceptible land and crops and triangulation of survey questions relating to crops grown and land owned.

The order in which transects were carried out was randomised on a stratified basis, choosing a random transect within each sample sector, the order of which was done by randomly assigned rotation. This was due to concerns held over conducting transects next to each other on consecutive days, thus potentially allowing neighbours to prompt others in advance. Also, as this process was expected to take several months, spanning a dry and wet season, bias due to seasonal variation was minimized through a random order of execution.

4.4.2 Focus groups

4.4.2.1 Development

The protocol for focus groups was largely advised by the SEAGA (Socio-economic and Gender Analysis Programme) Field Level Guidelines on Participatory Rural Appraisal (Wilde, 2001) which are aimed at self-guided problem discussion and solution. Experiences of previous HWC studies utilising focus groups were also integrated (Priston, 2008; Austin et al., 2010; White and Ward, 2010). Using several tools detailed in the SEAGA guidelines (Table 4.4) structured around several key themes to be addressed in each focus group, a schedule was compiled. Though set topics of conversation were outlined from the outset, other topics raised, if relating to the targeted investigation of HWC, were also explored. Both gender and location along the forest boundary (and associated variation in environmental conditions and social structure) formed the between-group control characteristics for this (Knodel, 1993). The complete schedule can be found in Appendix A of this report.

Table 4.4: SEAGA tools used in focus group. The research aims to which these apply are listed in parentheses.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Participants</th>
<th>Procedure</th>
<th>Intention</th>
<th>Expected outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Village resource map</td>
<td>All, with special focus on quieter members of the group.</td>
<td>Using coloured pens and paper, participants draw locations of important resources in the community, including wood collection points,</td>
<td>Encourage participation of all present, as an ice breaker. Obtain useful information about local perception of resources.</td>
<td>Open discussion and revelation of perceived location of forest and other resources.</td>
</tr>
<tr>
<td>Activity</td>
<td>Participants/Method</td>
<td>Area of Impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water points, schools, roads, clinics, shops, places of worship and forest edge. Participants also asked to suggest changes to this based on future conditions and aspirations.</td>
<td>Participants decide what to include on this map and guide the process.</td>
<td>A clear picture of the cropping patterns of communities bordering VNP and an understanding of government control over cropping and perceptions of this.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farming system diagram &amp; discussion (RO2, RO3, RO5)</td>
<td>Those involved in farming activity. Using coloured pens and paper, participants indicate location of cropping areas, forest plantation and grazing land. Planting seasons discussed and questions asked about why certain crops are grown where, and who decides this.</td>
<td>Gain understanding of which crops were grown where and when, to assess whether patterns emerge in terms of proximity to forest. Establish the level of government control over agriculture.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair-wise ranking of livelihood limitations (RO2, RO3)</td>
<td>All, with special focus on quieter members of the group. Participant asked to brainstorm ideas about problems in the area. Matrix of priority composed through paired comparison.</td>
<td>Rank problems in the area. Participation and consensus from all desired. Human-wildlife conflict explored further when/if mentioned.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trend Lines (RO1, RO2)</td>
<td>All, with special focus on quieter members of the group. Participants asked to depict, with a handful of beans and a 12-month graph, how the intensity of problems listed have changed in recent memory (fig. 4.6).</td>
<td>Obtain annual trends of problems listed. If human-wildlife conflict listed, this is explored further. If obvious relationships exist between crops and problems these are probed further, encouraging the group to offer possible explanations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem analysis (RO1, RO4, RO5)</td>
<td>All, with special focus on quieter members of the group. Discussion regarding causes of the most important problems, including coping strategies and potential solutions. Trends in severity explored.</td>
<td>Encourage discussion of problems and foster problem-solving thought within communities. Particular attention paid to human-wildlife conflict if raised.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current and potential solutions to the problems and thoughts on how behaviour may alter the magnitude of these problems.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Gain understanding of which crops were grown where and when, to assess whether patterns emerge in terms of proximity to forest. Establish the level of government control over agriculture.
4.4.2.2 Procedure

Focus groups were conducted in local meeting places, usually a school classroom or church, with the permission of the relevant body. Accessibility of sites was dictated by weather and resultant conditions of tracks leading to remote areas, especially as this phase lay within the short wet season in Rwanda. Local leaders attempting to attend focus groups were asked to remain outside until the discussion was complete. Two research assistants were recruited for this phase. The primary research assistant was male in his late 30s, originated in a village close to the park, was well known locally and was educated to third level. The secondary research assistant was also male, in his late 20s, originated from the south of the country and was also educated to third level.

Discussion in focus groups was led by the primary research assistant acting as facilitator, as it was thought that his local origin and ethnic background as formerly-Hutu would give greater respect in this setting. Proceedings were recorded by the secondary research assistant, which included details of physical expressions, sarcasm and other reactions elicited by certain topics (e.g. private whispering and cynical laughter). I supervised proceedings, although being aware of my positionality I attempted not to intervene unless absolutely necessary and sat removed from the group and out of eye contact, as previous trials had revealed that participants tended to look to me for a reaction to certain topics if seated within the group. Each participant was given a plastic basin as thanks for their participation as, though often requested, monetary reimbursement was not thought apt.

In addition to group discussions immediately following completion of each focus group, an appraisal of tools and emergent themes was conducted following the completion of 3 pairs. This reflection phase involved both research assistants. Twelve focus groups were conducted in communities bordering VNP; two gender-specific focus groups in each of the 6 park-adjacent sample sectors (fig. 4.4). Transcriptions of these were composed by both research assistants from digital recordings within a couple of days of each. This was done on a rotational basis between male and female focus groups to avoid biases and maintain consistency. The first two focus groups were transcribed by both research assistants, which revealed no significant difference in consistency and accuracy translation.
4.4.3 Household survey transects

4.4.3.1 Development of survey

Preliminary investigation of socioeconomic surveys carried out around VNP prior to this project, by NGOs and independent economic analyses, highlighted their excessive length (> 3 hours of probing questioning) and inappropriate sampling methods. Consultation with enumerators involved in these revealed that several questions were regarded as being too probing and culturally insensitive. Both points were considered in developing the administered household survey for this study.

Following a review of the literature, several *a priori* themes of investigation were identified, to be included in the extensive quantitative phase of this research in addressing specific research objectives. These included recalled historical extent of crop raiding, the level of this problem presently, crops grown and estimates of the value of standing crops, land holding size, mitigation measures in place, whether children are involved in this and local use of forest resources. This stage was additionally intended to explore further the emergent themes identified through focus group analyses, a more detailed treatment of which can be found in the Results Synthesis chapter.

To test the potential for an insurance scheme, each respondent would be presented with a CV statement, outlining the theoretical operation of such a scheme. Participants were asked to...
express their willingness to pay into an insurance fund, involving a double-bounded dichotomous choice pair of questions coupled with a PPM to reduce protest and zero bids. This exercise would also estimate the amount of money farmers expected to pay to protect against crop raiding.

Measures of risk (exposure to raiding) would be quantified in this survey through measurement of distance to the forest, crops grown, level of agricultural control and location along the park boundary. Financial exposure would be measured through independent socioeconomic measurement of each household. In order to control for a person’s attitude to this risk (i.e. whether a person is averse to taking risks or is inclined to taking risks) an estimation of risk preference was additionally conducted with each respondent. This involved posing five lottery choices, which participants would decide upon in advance, followed by the flipping of a coin to determine each chance outcome (Table 4.5)

<table>
<thead>
<tr>
<th>Wager/ non play pay-out (RWF)</th>
<th>Chance</th>
<th>Potential pay-out (RWF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>50:50</td>
<td>100</td>
</tr>
<tr>
<td>100</td>
<td>50:50</td>
<td>200</td>
</tr>
<tr>
<td>100</td>
<td>50:50</td>
<td>300</td>
</tr>
<tr>
<td>100</td>
<td>50:50</td>
<td>400</td>
</tr>
<tr>
<td>100</td>
<td>50:50</td>
<td>500</td>
</tr>
</tbody>
</table>

The first game presented a good way of ensuring comprehension before proceeding, given that there was no potential gain to playing. Any winnings obtained were allowed to be kept. In this way, participants would not regard it as payment for participation, but rather an amount obtained based on chance. The range of potential winnings spanned 100RwF (approx. €0.60) – 1,500RwF (approx. €1.90).

The complete survey protocol, including survey questions, CV statement and risk preference game were to be conducted through Kinyarwanda by the primary research assistant. As such, these were blind retro-translated beforehand, to maximise both linguistic and conceptual equivalences (Larkin et al., 2007; Müller, 2007). Necessary modifications were made to the survey protocol following testing on trial transects. The finalised administered survey can be found in Appendix B.

4.4.3.2 Survey transects
Transect start points were reached by motorbike and hiking, using the handheld GPS to locate start points, end points and distant intervals. In this way, direct straight lines were not adhered to (given the terrain, this was impractical). A household or in-field worker could thus be located
within a 100m radius of points at intervals of 200, 400, 600, 800 and 1,000 metres from the forest edge. Between the 30th January and the 14th April, 40 transects were completed, yielding 180 administered surveys, averaging approximately 4.5 per transect (fig. 4.7). Some regions were much less inhabited than others or consisted of land much less suitable for tillage farming. As a result, respondents were not found in all distance intervals.

![Figure 4.7: The location of 40 survey transects running perpendicular to the boundary of Volcanoes National Park, along with the location of 180 surveys obtained.](image)

The primary research assistant was exclusively used to conduct surveys, due to his local origin and ethnic background. During the initial 15 transects, surveys were supervised, allowing comment on questioning style, recording of data and the manner with which respondents were dealt. Following this period, it was felt that the research assistant, having already been involved in the focus group phase of the project and subsequent questionnaire development, was adequately experienced to allow for lone enumeration. Of the two research assistants used throughout focus groups, the local resident was exclusively used in interview execution to reduce cultural biases. Intermittently, the research assistant would be accompanied and observed to ensure consistency. Each evening, following transect completion, data sheets were returned and digital recordings...
transferred to storage devices. Difficulties were addressed and minor modifications to protocol discussed. This continuous reflection on methodology and positionality proved useful in improving efficiency of data collection and in the willingness of respondents to partake. Participation in CV and risk preference exercises was limited by religion, as 7th Day Adventists were forbidden from gambling. Data from each survey was coded, digitised and stored for later analyses.

4.4.4 Monitoring

In order to establish extensive and empirical monitoring of crop raiding damages across seasons, local data collectors were recruited and trained under the following protocol.

4.4.4.1 Selection of data collectors
Twenty five young-adult, educated and motivated data collectors, of both genders, were recruited by members of the umbrella cooperative organisation ANICO. As recruitment was coordinated by VNP management, I carefully scrutinised this to reduce political appointments, nepotism and generally unsuitable candidates. Subsequently, two meeting were held with prospective collectors to assess their level of education, potential biases, willingness to participate and previous experience of HWC. Following this, minor changes were made to the group.

Based on recent zonation of RDB activity around VNP, data collectors were split into groups, with a Zone Supervisor assigned to each group of collectors. These supervisors were recruited from ANICO, with pre-existing payments through park revenue sharing covering these responsibilities. The full monitoring team is pictured in Figure 4.8.

4.4.4.2 Training
A large group training day was organised, involving a general presentation of my research intentions, an in-depth description of the theory and practice of recording GPS locations, and small theoretical and practical group work sessions. All presentations were presented directly in Kinyarwanda or translated in real-time. This was partially funded by RDB.

In-field group training days in each of the four zones were subsequently held, with groups varying in size from four to nine participants. Data collectors were instructed to respond to damage claims, in addition to walking amongst designated farmland on a minimum of 2 days per week. Data collectors were further instructed to independently corroborate damage claims made by farmers when responded to, through personally assessing damaged crops. Using spoor of implicated animals — such as tracks, teeth marks, claw marks, hair and faeces — they were to record the most likely raiding species. Additionally, data collectors were instructed on a method of simple area estimated using the GPS units. Each crop raiding event was classified as damage to
a defined plot of cultivated land (usually a standard 40 x 50m plot). Accuracy in filling out records sheets was improved and all were encouraged to remain in contact with neighbouring collectors, zone supervisors, my research assistant and park staff. This provided a support structure for often-isolated collectors and reduced overlap of records with neighbouring data collectors. Upon completion of this, all data collectors were issued with certificates of GPS competency.

Figure 4.8: Data collectors recruited for crop damage monitoring, including four zone supervisors, and VNP management.

4.4.4.3 Infrastructure

Each data collector was issued with a GPS unit, waterproof folder, pens, writing pads and data collection sheets (Appendix C). Replacement batteries and technical knowledge of GPS use was given by the primary research assistant as required. Completed sheets were gathered and returned to VNP headquarters by Zone Supervisors at the end of each month. During data sheet submission, issues with data collection were passed to collectors through the Zone Supervisors. Upon collection of all data sheets each month, the primary research assistant digitised this and emailed this to Ireland.

Full payment of these data collectors was not given as it was felt that the work would not justify a locally average full-time wage. As such, a cost-sharing agreement was reached with RDB and I to cover an 'incentive' for data collection. All collectors and Zone Supervisors accepted these terms, with the understanding that valuable skills and experience would be obtained.
Monitoring for this study was intended to span 12 months, to capture as much temporal variation in HWC and its potential determinants as possible. It was hoped that, if successful, RDB may continue and improve upon this system, advising improvements to conservation and agriculture practices which lessen the impacts of conflict.

4.4.5 Boundary survey
Recent rebel disturbances in DRC, in addition to the chance of encountering dangerous wildlife, necessitated that I and my primary research assistant were accompanied by an armed VNP Ranger during the survey of the VNP boundary. The boundary walk was completed in five days, staying along the forest margin overnight in VNP Ranger camps. Food, communications and security were provided by VNP Rangers and Rwandan military throughout the trip. Efforts were also made to involve local community leaders and volunteers. These local representatives included volunteers from the ANICO umbrella organisation and long-term monitoring data collectors, where available to assist. The data collection sheets used for this can be found in Appendix D.

4.5 Field data collection methods – secondary data

4.5.1 National University of Rwanda – Centre for GIS
Extensive digital mapping of Rwanda has been underway for several years, resulting in a large collection of spatial layers. These include land-use, forest cover, roads, waterways, inhabited areas, topography, climate, human population and administrative boundaries. As part of a relationship established with the National University of Rwanda (NUR), access to these data was granted through the Centre for Geographical Information Systems (CGIS), Butare; a subsidiary of NUR.

The recent administrative changes in Rwanda, with large-scale name and delineation changes mean that some data were based on old administrative boundaries. Consideration of this was required when dealing with population data and planning for sampling.

4.5.2 Remote open access data
High resolution satellite imagery was used to assist in identifying sites, meeting points and accessibility of sites. These were obtained from Google Earth® under their free usage copyright policy. These images were additionally used to identify areas of extensive eucalyptus plantations along the VNP margin, and to confirm the locations of ravines and water courses as identified in CGIS data and the boundary survey protocol.
A comparative satellite image layer was also obtained through freely available Landsat Imagery databanks administered by the US Geological Survey from the GloVis® system. As more recent images of the area (though containing a higher percentage of cloud cover) these corroborated Google Earth images.

A Digital Elevation Model (DEM) of the required grid was downloaded free from the Earth Remote Sensing Data Analysis Center (ERSDAC) and used to obtain elevations on a 1 arc-second (approx. 30m) scale. The accuracy in elevation of this layer was tested in the field using handheld GPS units with differences found to be negligible. Using this DEM layer, data for slope and aspect were derived using the Spatial Analysis tools of Arc-Map.

4.5.3 NGO and VNP data

Data sets pertaining to seasonal movement of Gorilla groups, habitat types within VNP boundaries, tracks used by trackers and anti-poaching teams, locations of snares destroyed by anti-poaching teams and locations of visible human use of forest resources were collected from the DFGFI Karisoke Research Centre. Use of these data was given under the condition of shared findings and acknowledgment. Historical data on crop raiding collected by VNP Rangers was very limited and poorly recorded, reducing its usefulness and credibility.
5. Methodology: Collation and Analysis

5.1 Overview
This chapter outlines the analyses employed to address the research objectives of this study. This includes a description of coding across focus groups and administered surveys, with subsequent re-aggregation and cross-referencing for triangulation of results. Additionally it describes the collation of monitoring data and the analyses used to investigate the form, level, range and likely determinants of conflict along the margins of VNP. Finally, an account is given of the valuation techniques used to test the willingness to pay into an insurance scheme as a means of mitigating loss incurred through crop raiding.

5.2 Data collation

5.2.1 Focus groups
Following transcription of digital recordings for all 12 focus groups, emergent themes, identified in preliminary analyses and focus groups, were highlighted and structured into a hierarchy with subordinate categories, in addition to data on pre-prescribed issues including crop raiding. Statements and observations applying to each were coded to these themes and combined into thematic blocks, allowing for interpretative analysis of interactions and recurring patterns. Quotations of use were noted (Knodel, 1993) for later interconnection with other qualitative methods in addressing specific research objectives.

Data on cropping trends were combined across all focus groups, while maintaining location and gender information. Quantification of this was expressed in focus groups through the distribution of a fixed handful of beans among 12 months. These expressed amounts were then generalised into 5 increments which were used as rudimentary quantifications of cropping intensity and priority. Absolute means for these were calculated for each crop and month.

The lists of problems cited were collated into a single list, with monthly trends in these investigated in the same way as cropping trends, above. Expression of trends in this way was more limited than cropping, owing to focus group time restrictions. Data pertaining to pairwise ranking of problems required adjustment of quantifications given, based on the number of problems cited within each focus group and the ranked position within each list. The assumptions for this adjustment were that 1) a lower ranking would lead to a lower intensity value, and 2) a
greater number of problems in a given ranking exercise would lead to lower values of all problems. Consideration of these assumptions led to the following adjustment function being developed.

Where \( V \) is the expressed quantification of problem intensity per month, \( R \) is the rank assigned to this problem by a focus group, and \( N \) is the number of problems listed in each focus group, then;

\[
Adjusted \ Intensity, \ I = \frac{V}{R \times N}
\]

Further permutations of this led to various alternative adjustment factors which included the addition of the term \( \frac{R+1}{R} \) to account for ranking position in varying list numbers, and the use of a logarithmic scale to dampen variability following adjustment.

Findings of the aggregation analyses were used in addressing specific research objectives, in addition to advising directed questions of household surveys and modifications to monitoring practices.

5.2.2 Administered surveys
Survey data was digitally coded from recording sheets following each transect day. Quantitative data from these were standardised and categorised where necessary, while qualitative statements were coded and interconnected with the focus group thematic hierarchy, for use in addressing specific research objectives later in this chapter. All survey data were imported into IBM SPSS v.20 (IBM Corp., Armonk, NY) statistical analysis software for later use. The distance from the VNP boundary to the location of each respondent's land holding or place of work was derived using the GPS location and the 'Near' tool in Arc-Map.

5.2.3 Monitoring
Data collected by field observers was submitted to Zone Supervisors and digitised by the research assistant. Errors in recording digits of locational data were corrected where possible through initial visualisation in Arc-Map as monthly shapefiles, followed by triangulation with recorded cell name, altitude and data collector. Adjusted monthly data sets were then collated, creating an annual data set spanning January - December 2012.

In addition to using raw point data, these data were converted to 500 x 500 m and 1 x 1 km grid density layers across the study area. The dimensions of these grids were used as a compromise between enhanced local resolution of analyses and retaining sufficient range of other variable values. This was done under concerns of possible multicollinearity among variables (particularly proximity measures) at point level and was achieved by overlaying a grid of both sizes over the layer containing raiding data, using the Fishnet function of the Data Management Arc-Map.
toolbox. The frequency of raiding events within each grid polygon was then calculated using the Zonal Statistics tool and spatially joined to the grid polygon layer at each resolution. Polygons with no raiding events recorded were then removed from each of these layers for ease of visualisation and analysis.

5.2.4 Boundary walk
Data from collection sheets were digitised and visualised in Arc-Map to identify incorrectly recorded locations. Where possible, these were corrected based on the known location of the VNP boundary. Measurements of wall quality were interpolated in Arc-Map, using Inverse Distance Weighted (IDW) interpolation, to derive a wall quality index raster surface for use in later stages of analysis. Proximities to gaps in defences (human use and river ravine) were derived using the Point Distance tool, yielding two more raster surfaces.

5.3 R01 – Determine the form, level and range of human-wildlife conflict experienced by farmers adjacent to VNP
To address this research objective, the results of preliminary analyses, focus groups and household surveys were combined to qualitatively characterise conflict between the fauna of VNP and park-adjacent farmers, including its perceived socioeconomic impacts. The results of systematic monitoring were then assessed under several classes of variability, to quantify the form, level and range of observed conflict.

5.3.1. Human-wildlife conflict: perceived and predicted

5.3.1.1 Problem analysis
Following resource mapping and pairwise ranking in focus groups, comparisons were made between issues thought to limit farming practices in terms of absolute numbers of problem citations and the position of these problems within each set. It was to be shown in this analysis whether crop raiding was seen as one of a myriad of restrictions on farming livelihoods or whether it existed as a distinct and significant problem. Where cited, accounts of the nature of this conflict were compared across focus groups.

5.3.1.2 Crop raiding
Conflict between VNP and adjacent land-users was assessed through the expressed perception of monthly crop raiding intensity from focus groups, using collated and adjusted data. Reported seasonal changes in the intensity of HWC, in line with changes in cropping calendars, resource availability and land tenure issues, were assessed and compared to reported intensity of crop
raiding. The emergent themes hierarchy was used to structure this analysis, utilising supporting quotations and information obtained from preliminary analysis.

5.3.1.3 *A priori* predictive surface

As an indicative tool, derived raster data for a number of likely predictor variables (Table 5.1) were overlaid using the Raster Calculator tool in Arc-Map to give a generalised predictive surface for the likelihood of raiding.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Assumption</th>
<th>Term used in calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to park</td>
<td>Lower distance = greater raiding rate</td>
<td>1 / Euclidian distance to park</td>
</tr>
<tr>
<td>Distance to paved road</td>
<td>Greater distance = greater raiding rate</td>
<td>Euclidian distance</td>
</tr>
<tr>
<td>Distance to river</td>
<td>Lower distance = greater raiding rate</td>
<td>1 / Euclidian cost distance, weighted by slope</td>
</tr>
<tr>
<td>Population density</td>
<td>Greater density = greater land-use</td>
<td>People per km² by sector</td>
</tr>
<tr>
<td>Altitude</td>
<td>Lower altitude = greater land-use</td>
<td>1 / DEM* value for altitude</td>
</tr>
<tr>
<td>Slope</td>
<td>Greater slope = greater damage</td>
<td>Slope derived from DEM</td>
</tr>
<tr>
<td>Distance to urban area</td>
<td>Greater distance = greater raiding rate</td>
<td>Euclidian distance from urban areas</td>
</tr>
<tr>
<td>Distance to ravine gap in wall</td>
<td>Lower distance = greater raiding</td>
<td>1 / Euclidian cost distance, weighted by slope</td>
</tr>
<tr>
<td>Adjacent wall quality</td>
<td>Lower quality = greater raiding</td>
<td>IDW* of 200m interval measurements</td>
</tr>
<tr>
<td>Distance to gap in wall</td>
<td>Lower distance = greater raiding</td>
<td>IDW of events points</td>
</tr>
</tbody>
</table>

Following derivation of raster data, the values of each variable were divided into 10 categories using the Slice Tool of Spatial Analyst, for ease of comparison and to allow for meaningful addition. Initial surfaces generated exhibited excessive dependence on population density, owing to the poor resolution of available data. Further raster surfaces were calculated by excluding categorical population density values.

5.3.2 Extent and range of crop raiding

5.3.2.1 Variation in crop raiding

Descriptive statistics on the numbers of raiding events (defined as damage to the predominant crop in a defined plot of cultivated land) were summarised. Additionally, crops affected were summed and cross-tabulated with species implicated.
Faunal variation
Discernible patterns in distribution of species-specific raiding accounts were visualised in Arc-Map, overlaying park boundaries, water course and international boundaries. The variation of each species' crop raiding range was then described.

Spatial variation
A preliminary analysis of crop raiding distribution was carried out by totalling numbers of raiding events (i.e. damaged plots) per park-adjacent cell. This was then normalised based on length of park perimeter per cell. To obtain a finer resolution of clustering, the Point Density tool in the Spatial Analysis tool kit of Arc-Map was used, using default settings for a circular radius of point calculation. Though this gives adequate visualisation, a significance level for clustering in these data points was then obtained through Multi-distance Spatial Cluster Analysis, giving Ripley's K-statistic for levels of clustering at short and long distances. A set of 50 distances and 9 permutations of random point overlay were used to estimate this. These were chosen to optimise the ability to detect plot-level (50 x 40 m) clustering in conjunction with boundary-wide (65 km) dispersion of clusters. A minimum enclosing rectangle of analysis extent accounted for the reduced neighbour effect of points lying on the edges of the geographical distribution. Using this, a statistical measurement for clustering and dispersion at varying distances in the study area was obtained.

Temporal variation
Trends in day versus night raiding were compared as part of species-level intensity comparisons, while monthly HWC intensity trends were graphed alongside rainfall and cropping trends to show annual trends. This annual trend was then visualised by creating a time-series animation of the monitoring data set.

5.3.3 Socioeconomic impacts of crop raiding
Socioeconomic costs incurred as a result of HWC were measured using several tools across a number of methods. Claims of costs incurred during preliminary investigations, focus groups and qualitative sections of surveys were coded and aggregated into three thematic areas; asset loss, opportunity costs and development restrictions, which were individually analysed. Geographic variability in these was also assessed, where possible.

5.3.3.1 Nature and level of socioeconomic loss
Accounts of asset loss, including loss of goods intended for resale or the equivalent market value of crops lost, based on 2012 northern Rwandan prices, were re-aggregated and discussed, while quantification of this was derived, where figures were available, from administered survey respondents and monitoring data.
Prescribed opportunity costs associated with HWC identified from previous studies and which were expected in this case study were assessed, including rates of child crop guarding and potential exposure to vector-borne disease. Qualitative analysis of these was synthesised from preliminary investigations and focus groups, while quantification was obtained from survey transects. Additionally, emergent opportunity costs were identified through qualitative analysis, which were quantified where possible.

Investigations of development challenges posed by HWC were conducted using accounts of preliminary investigations and focus groups, such as the prescribed theme of reduced dietary diversity as a consequence of crop modification (Hoare, 2000; Akankwasah, 2008; Ogra, 2008). Emergent themes were similarly analysed and cross-referenced between methods.

5.3.3.2 Geographic variation
Smoothed raster surfaces showing the variability of HWC damage intensity were derived through IDW interpolation of point values using the IDW tool of Arc-Map, using variable radius distance to obtain 12 vector point values for each raster point. This was then compared with the crop raiding frequency layer derived in previous analyses. Survey and monitoring data GPS locations then allowed for visualisation of variability in the above socioeconomic effects of HWC. This was achieved through differential colouration of survey and monitoring point layers, such as household expenditure on mitigation and accounts of child guarding.

5.4 RO2 – Establish the likely determinants of conflict, including spatiotemporal variation
This section outlines the analysis conducted towards establishing the likely determinants of HWC around VNP. This includes a qualitative assessment of findings from preliminary investigation, focus groups and surveys, and a quantitative assessment using systematic monitoring data.

5.4.1 Preliminary investigation, focus group and administered survey findings
Claimed determinants of crop raiding around VNP included regional agricultural practices, VNP ecology and the governance of adjacent farmland. These were assessed through focus group transcripts, key informant interviews and survey responses. These were combined and analysed for commonalities in causation and variation, while the importance of each posited determinant was assessed through non-parametric regression analysis.
5.4.1.1 Agricultural determinants
Expressed causes of crop raiding and factors exacerbating its effects were identified from focus group transcripts. Qualitative accounts were then compared with investigation of these determinants carried out during survey transects. This included visualisation of cropping calendars derived from focus group seasonal grid exercises. Comparison was then made with expressed levels of crop raiding and other livelihood limitations.

5.4.1.2 Ecological determinants
Characteristics of VNP determining level of crop raiding, as expressed in preliminary investigations with conservation organisations, park management, cooperative leaders, development NGOs, focus group discussions and survey statements were analysed through aggregation of coded qualitative data and triangulated across methods.

5.4.1.3 Quantitative modelling
Similar studies of HWC, including studies of carnivore predation (Pitman et al., 2012), crop raiding (Sitati et al., 2003) and household welfare (Richardson et al., 2012) have utilised non-linear predictive models to test stated determinants of conflict. A similar model was constructed here to quantify the importance of pre-identified and emergent determinants in perceptions of crop raiding by forest animals. Composition of this predictive model first required derivation of geographical data and comparison of triangulation questions. Data from administered surveys previously coded in IBM SPSS were utilised for this purpose.

Following derivation and adjustment, 15 potentially-explanatory variables were used in model testing (Table 5.2), including demographic, geographic, agricultural and socioeconomic factors. Given that the dependent variable of experiencing crop raiding was a binary dependent variable (0/1), stepwise binary logistic regression using multiple variables was run to obtain the most parsimonious model.

This model was simplified through stepwise backward-elimination using the Wald statistic (α = 0.5) to remove non-correlated variables, while the adjusted Akaike’s Information criteria (AICc) tested the parsimony of resultant models. The models’ goodness-of-fit were tested using the Hosmer-Lemeshow statistic and by measuring the area under the Receiver Operating Characteristic (ROC) curve (Pitman et al., 2012).
Table 5.2: Variables used in multivariate logistic regression model development.

<table>
<thead>
<tr>
<th>Variable description</th>
<th>Variable Name</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender of respondent</td>
<td>Gender</td>
<td>Continuous</td>
</tr>
<tr>
<td>Age of respondent</td>
<td>Age</td>
<td>Binary</td>
</tr>
<tr>
<td>Size of household</td>
<td>Hshld size</td>
<td>Continuous</td>
</tr>
<tr>
<td>Household robustness*</td>
<td>Socio.cat2</td>
<td>Ordinal</td>
</tr>
<tr>
<td>Years resident in area</td>
<td>Residence</td>
<td>Continuous</td>
</tr>
<tr>
<td>Size of land holding</td>
<td>Plotsize</td>
<td>Continuous</td>
</tr>
<tr>
<td>Distance of farmed land to the VNP boundary</td>
<td>Distance</td>
<td>Continuous</td>
</tr>
<tr>
<td>Ownership of land (Y/N)</td>
<td>Ownership</td>
<td>Binary</td>
</tr>
<tr>
<td>Control of land (Y/N)</td>
<td>Cropchoice</td>
<td>Binary</td>
</tr>
<tr>
<td>Who controls land</td>
<td>Whochooses</td>
<td>Categorical</td>
</tr>
<tr>
<td>Land tenure influenced by local agro-industry</td>
<td>Sopyrwa.infl</td>
<td>Binary</td>
</tr>
<tr>
<td>Travel time to dry season water source</td>
<td>Water</td>
<td>Scalar</td>
</tr>
<tr>
<td>Mixes crops on plot (Y/N)</td>
<td>Intercrop.2</td>
<td>Binary</td>
</tr>
<tr>
<td>Access to market (Y/N)</td>
<td>Market</td>
<td>Binary</td>
</tr>
<tr>
<td>Obliged to grow pyrethrum (Y/N)</td>
<td>Pyrethrum</td>
<td>Binary</td>
</tr>
<tr>
<td>Estimated value of crop per season</td>
<td>Seas.crop.val</td>
<td>Continuous</td>
</tr>
</tbody>
</table>

*Household robustness is a measure of household resilience to change, using an aggregate of socioeconomic category through house build type, reduced exposure to common diseases through solid floor and external cooking hut, numbers of livestock owned, presence of aesthetic garden indicating disposable time.

5.4.3 Multivariate modelling of monitoring data
Though having fewer variables per record than survey data, the extent and coverage of monitoring data allowed for detailed multivariate spatial modelling to be conducted. A combined Ordinary Least Squares (OLS) regression model was designed to characterise the interplay between explanatory variables and assess the relative importance of each.

For each account of raiding damage several types of data were collected. These included the type and number of animals implicated, time of day, type of crop damaged and categorical growth stage of this, area damaged and distance to the nearest habited building. Furthermore, from the GPS coordinate taken of each point, important spatial information was derived, using other forms of primary and secondary spatial data, which were appended to each raiding account record in mapping software. These include proximity to VNP, roads, rivers and ravines, the altitude and slope at each point, and the quality of adjacent VNP boundary defences obtained from the boundary survey and subsequent interpolation of this data (see section 5.2.4). Furthermore, each species of raiding animal was assigned an ascending potential damage category of 1-7 (Table 5.3), in line with body mass, using standard adult male weights (Stuart and Stuart, 2006). Though body
mass may not always be proportional to feeding-related damage per animal (e.g. Mackenzie, 2012), preliminary investigations revealed that larger animals were implicated in significant levels of trampling, without feeding, in addition to crop feeding. This did not account for animal age, which could not be reliably measured by data collectors.

Table 5.3: Adult male body masses of the 7 implicated raiding species around VNP, and assigned category.

<table>
<thead>
<tr>
<th>Species</th>
<th>Male adult body mass (kg)</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>African elephant ssp.</td>
<td>2,800-3,200 /5,000-6,300*</td>
<td>7</td>
</tr>
<tr>
<td>Buffalo</td>
<td>320-700</td>
<td>6</td>
</tr>
<tr>
<td>Mountain gorilla</td>
<td>140-180</td>
<td>5</td>
</tr>
<tr>
<td>Bushbuck</td>
<td>45</td>
<td>4</td>
</tr>
<tr>
<td>Porcupine</td>
<td>10-24</td>
<td>3</td>
</tr>
<tr>
<td>Black-fronted duiker</td>
<td>13-16</td>
<td>2</td>
</tr>
<tr>
<td>Golden monkey</td>
<td>8-10</td>
<td>1</td>
</tr>
</tbody>
</table>

*Though the distributions of two subspecies of African elephant (Forest and Savannah) are known to overlap in VNP (Blanc, 2008), the body mass of either still vastly exceeds that of buffalo.

Data for absolute damage incurred at each recorded location were not normally distributed (Skewness = 5.7; Kurtosis = 63.7), which was normalised through log transformation. The normality of potentially-explanatory variables was tested using histograms and necessary transformations of data were performed. The relationships between Log damage and potentially-explanatory variables were examined using a scatterplot matrix in Arc-Map to examine collinearity. Variables were then sequentially added to an OLS model, using the Spatial Analyst Tools of Arc-Map. Model variables were assessed for fit to prior assumptions, with non-significant variables being removed (based on the p-value of each). If non-stationarity (i.e. likely spatial variability in the model relationship) existed for any significant variable, as measured by the Koenker Test (Koenker and Bassett, 1982), only the robust probabilities was trusted for this variable. Redundancy of variables in the form of multicollinearity (correlation between two explanatory variables) was reduced by removing those variables displaying a Variance Inflation Factor (VIF) exceeding 7.5 (Marquardt, 1970). Good model performance was assessed using a Pearson’s Correlation Coefficient (R²) close to 1, where zero indicates no model fit and 1 represents perfect fit. Bias of this model was tested using the Jarque-Bera test of homoscedasticity (Bera and Jarque, 1981), which indicated whether or not the variance of all variables were equal. If significant (indicating homogeneity of variance) the model must be rejected on the grounds that an underlying factor was influencing the OLS relationship.
If well-specified with a high $R^2$, accepted by the Jarque-Bera test and containing variables with significance and low VIF values, the overall model residuals were tested for spatial autocorrelation using Moran's $I$-statistic (Moran, 1950), which would show the degree to which model variables were spatially autocorrelated. If clustering was still observed, this would indicate that another variable was affecting the coefficients of each variable, such as space or time. Though this may be explained through interaction terms between covariates, understanding the complex socio-ecological interactions in this scenario was infeasible (Nakaya et al., 2005).

5.5 RO3 – Determine the impacts of HWC on tourism and VNP conservation

This section outlines the analysis conducted to characterise the impacts of human-wildlife conflict on the conservation of VNP and its continued use as a tourism resource, using the findings of preliminary investigations, focus groups and survey transects.

Achieving this analysis required aggregation and interconnection of qualitative data obtained, and was analysed separately for prescribed and emergent themes, triangulating responses across the various methods for each of the thematic issues highlighted. Specific statements pertinent to each theme were included within the context of the broader thematic discussion and in light of information available from other sources, such as key informant interviews and personal observation.

Pre-identified issues included obtaining the perceptions of conservation and tourism held by park-adjacent communities, the impacts of HWC on this and the extent to which revenue generated through tourism is shared with these communities.

Where applicable, and allowed by data collected, spatial variability in perceptions of forest conservation and the impact of HWC on this were visualised in Arc-Map. Chi-square analysis was then used to assess the dependence of attitudes to conservation on distance to the VNP boundary split into quintiles, as measured through responses to the survey question “Are RDB doing enough to protect the park and the people who live around it”. Similar studies have found this to be significant in determining attitudes to conservation (Harter et al., 2011). Additionally, views on conservation were tested against the derived measure of 10-year raiding event recall. In this way it was hoped to quantitatively test whether attitudes to conservation are affected by perceived levels of conflict with forest-dwelling animals.
5.6 RO4 – Ascertain the nature, extent and effectiveness of current mitigation and appraise potential future solutions
To achieve this research objective, re-aggregation and triangulation of qualitative data from preliminary investigations, focus groups and administered surveys was carried out to gain an understanding of mitigation in place, its perceived effectiveness and limitations associated with each approach. Georeferenced measurements of boundary defence quality were mapped, while views on future solutions posited by affected farmers and VNP management were compared and contrasted.

5.6.1 Current mitigation
Data gathered throughout preliminary meetings, personal field observations and focus groups pertaining to prevention of HWC were aggregated to ascertain the variety and perceived extent of mitigation measures in place. This was divided into three categories; active guarding, physical barriers and other mitigation in place.

Investment of money and time into active guarding was assessed specifically, through standardisation of accounts given during survey transects, in response to the question “How much time/money do you spend doing this (guarding)”\textsuperscript{1}? Investment in mitigation was then compared to socioeconomic class and distance to the VNP boundary, as carried out by Hartter et al. (2011), under the assumption that higher socioeconomic category and proximity to the park are related to ability and necessity to mitigate, respectively.

Boundary survey data relating to the quality and extent of defences were visualised in Arc-Map. This included the presence or absence of a wall, the quality of wall where present, locations of defence gaps and areas of discernible human transgression into forest territory. These data were then overlaid with raiding intensity data obtained in RO1 to compare responses and effectiveness of prevention measures.

Data from focus groups and survey transects relating to other forms of mitigation were then combined in an analysis of other existing mitigation measures in place. Perceived limitations of active guarding, physical barriers and other mitigation measures expressed in preliminary investigations, focus groups and qualitative survey statements were also aggregated and included in the assessment of each strategy.

5.6.2 Future solutions
Also assessed through preliminary investigation, focus groups and administered surveys were proposed solutions to the problem of crop raiding by forest-dwelling animals. Commonalities among these solutions were compared across sources, from forest-adjacent farmer to VNP
management. Subsequently, applications of these proposed mitigation improvements in other case studies of HWC globally were assessed for viability in this case study.

5.7 RO5 – Assess the potential of an insurance scheme to mitigate losses due to conflict

This research objective addressed the potential for novel mitigation of damages due to crop raiding through a locally-run insurance scheme. This was achieved by assessing existing acceptance of similar schemes in northern Rwanda and the appropriateness of the proposed insurance. Subsequently, analysis of the CV data was intended to estimate a premium function for monthly insurance payments.

5.7.1 Justification for insurance fund

In order to first assess whether a proposed shared insurance fund would be understood and accepted, a qualitative investigation of similar schemes, and perceptions of these, was conducted using data derived from preliminary investigations, focus groups and administered surveys. Factors dictating respondents’ willingness to participate in the scheme were then tested.

5.7.2 Contingent valuation through willingness to pay

5.7.2.1 Overview analysis

In order to predict willingness to pay into an insurance scheme using figures obtained through double-bounded dichotomous choice (DC) questioning, preliminary overview analyses were conducted to assess data suitability and adherence to basic assumptions of value and reactions to pricing. The proportion of those not willing to pay were compared to each randomly selected DC value. From this it would be possible to observe whether a reduced willingness to pay with increasing price of a potential insurance scheme was present and whether a difference was observed in the first and second DC question responses.

5.7.2.2 Model development

Development of a CV function for a potential insurance scheme was not possible due to violation of valuation assumptions. However, analyses of responses to each dichotomous choice question were conducted through scatterplot and linear regression. Data were then split into discrete data classes that may have potentially dictated this unexpected result.

5.7.3 Willingness to participate

In addition to calculation of figures for proportional support for a locally-run insurance scheme, pertinent quotations given in open-ended responses were included to corroborate these findings.
Though this study was unable to construct a valuation model using the CV data, hypotheses on the level of participation in a proposed insurance scheme could be tested. Comparisons between participation rate and several socioeconomic and demographic variables collected during survey transects were made, following Poe et al. (2002) and using the alternate hypotheses in Table 5.4. Those farming their own land, and thus directly liable to losses, were expected to be positively correlated with insurance scheme participation. It was also assumed that those with control over the crops they grow would be more likely to pay into an insurance scheme, by virtue of having greater personal interest in crops and being less reliant on local government for support.

Increasing age was assumed to correlate with less education, especially of insurance schemes, and so it was expected that older participants would be less likely to contribute. Though no assumption of correlation sign could be made based on gender, differences in perceptions of crop raiding and farming strategies were observed in focus groups. Respondents of higher derived socioeconomic status were assumed to be better able to afford monthly insurance payments. Having a larger household, conversely, was assumed to reduce their ability to contribute. Those farming closer to the forest, and therefore more exposed to potential raiding, were assumed more likely to contribute, while greater land holding was thought to cause greater potential exposure to raiding and provide additional disposable income to invest in insurance.

<table>
<thead>
<tr>
<th>Assumptions and scale</th>
<th>Expected Sign of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation of farmers on collective land &lt; participation of those farming own land. (Own = 1)</td>
<td>+</td>
</tr>
<tr>
<td>Participation of farmers with no control over crops &lt; participation of farmers with control (Self-control = 1)</td>
<td>+</td>
</tr>
<tr>
<td>Age (numeric)</td>
<td>-</td>
</tr>
<tr>
<td>Male participation # Female participation (Male = 1)</td>
<td>?</td>
</tr>
<tr>
<td>Derived socioeconomic status (categories1-4)</td>
<td>+</td>
</tr>
<tr>
<td>Household size (numeric)</td>
<td>-</td>
</tr>
<tr>
<td>Distance to forest ∝ 1/Participation (categorical: 1-5)</td>
<td>-</td>
</tr>
<tr>
<td>Plot size ∝ Participation (numeric)</td>
<td>+</td>
</tr>
</tbody>
</table>

A binary logistic model, built in IBM SPSS, tested for the significance of the above hypotheses and their role in dictating participation in an insurance scheme. This was conducted to assess the conditional proportion and significance of explanatory variables (Poe et al. 2002), though was not intended to predict which respondents would participate. The calculation of several goodness-of-fit and model specification measures aided in this (Bewick et al., 2005).
6. Results

6.1 Overview

The following section outlines the basic results obtained from the five sets of methods used in data collection. Use of these data in addressing specific research questions is expanded upon in subsequent sections of this chapter.

In general, little opposition to this research was encountered, with cooperation obtained from most survey respondents and focus group participants. Seeking prior approval from, and maintaining contact with, local leaders reduced suspicion of this research. Independence from Government of Rwanda or NGO sponsorship further reduced suspicion.

6.1.1 Preliminary analyses

Thematic areas emerged through attendance at six public meetings, conducting eight key informant interviews, informal discussions with conservation practitioners and local farmers, and extensive informal observations. Passages of transcripts and accounts of observations pertaining to these were subsequently used to bolster the findings of specific research objectives.

<table>
<thead>
<tr>
<th>Major Theme</th>
<th>Subordinate theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildlife Value Orientation</td>
<td>• Ecological understanding</td>
</tr>
<tr>
<td></td>
<td>• Responsibility for forest and its conservation</td>
</tr>
<tr>
<td></td>
<td>• Use of forest</td>
</tr>
<tr>
<td>Governance</td>
<td>• Disillusionment with government policy</td>
</tr>
<tr>
<td></td>
<td>• Lack of agriculture control. Gov. and externals in control</td>
</tr>
<tr>
<td></td>
<td>• Unwillingness to speak candidly / fear of expression</td>
</tr>
<tr>
<td>Cultural Conflict</td>
<td>• Batwa Animosity</td>
</tr>
<tr>
<td>Perceptions of crop raiding problem</td>
<td>• Gorilla insignificance</td>
</tr>
<tr>
<td></td>
<td>• Desire to exaggerate crop raiding</td>
</tr>
<tr>
<td></td>
<td>• Buffalo raiding prominence</td>
</tr>
<tr>
<td></td>
<td>• Solutions offered</td>
</tr>
<tr>
<td></td>
<td>• Reduced dietary diversity</td>
</tr>
<tr>
<td>Economics</td>
<td>• Access to the market economy</td>
</tr>
</tbody>
</table>
6.1.2 Focus groups

Mean attendance of focus groups was 7.8 participants, with a mean duration of one hour. Following coding analysis and aggregation of commonalities within focus group transcripts, 13 thematic areas were identified. These were a combination of emergent themes and those which formed part of prescriptive investigations identified in existing literature or through preliminary investigations. These were then grouped into 5 major thematic areas (Table 6.1).

6.1.3 Administered surveys

Survey transects yielded 180 respondents across 6 sectors of park-adjacent land, spanning a dry and wet season. Age of respondents was normally distributed, derived household robustness was significantly skewed toward lower levels and gender division was roughly equal. Mean household size was 5 individuals and was normally distributed.

Socioeconomic status, as assigned by Rwandan local authorities, was found to be highly skewed towards lower categories (poorer households). Independently-derived measures of socioeconomic status, taking into account house build type, land holding, cooking conditions, possession of livestock and land holding size, revealed similar skew in wealth distribution within sample communities (fig. 6.1).

Figure 6.1: Histogram displaying the distribution of derived socioeconomic status index with inclusion of land holding size. Mean = 13.7929, Std. Dev. = 0.55461, N = 180
When categorised into four equal divisions, a Wilcoxon Signed Rank Test revealed a significant difference between government assigned socioeconomic levels and those assessed through observation of various household characteristics ($Z = -10.554$, $p \ll 0.05$). In general this difference was characterised by a marked increase in poorest households (fig. 6.2 a - b). Given that this derived level also considers factors influencing healthcare and domestic assets, it was used in subsequent analyses, as a broader measure of a household’s resilience to the effects of crop raiding loss.

![Histograms showing the distribution of categorical household socioeconomic status](image)

**Figure 6.2, a - b:** Histograms showing the distribution of categorical household socioeconomic status, (a) as assigned by the Rwandan government and (b) those derived from independent assessment. $N = 180$.

### 6.1.4 Boundary walk

A total of 327 continuous data points were collected at 200m intervals along the park boundary, in addition to 265 data points relating to locations of guarding huts, gaps in the wall (human and animal use) and water course ravines.

### 6.1.5 Monitoring

The 12-month period of monitoring yielded 3,490 georeferenced data points across 26 of the 29 park-adjacent cells, in addition to some cells further from the park. Missing field information reduced this number slightly for relevant analyses. Collation and transformation of these data into grids of 500 x 500m and 1 x 1km allowed for density mapping of these points.
6.2 RO1 – Determine the form, level and range of human-wildlife conflict experienced by farmers adjacent to VNP

This section describes the results of investigations into the form, level and geographical extent and variation of HWC, specifically crop raiding, around VNP. Beginning with a qualitative investigation of problem definition, this section then details commonalities in crop raiding discourse throughout preliminary investigations and focus groups, before describing both the predicted and actual variability in this. Finally, the socioeconomic impacts of crop raiding on local farmers are assessed through various measures.

6.2.1 Summary

Pairwise ranking revealed that crop raiding is a prominent perceived livelihood restriction. Mountain gorillas were not significantly blamed for crop raiding, which was dominated by accusations of buffalo and golden monkey raiding. Monitoring confirmed this, further showing the widespread nature of the problem, the predominance of which occurred at night. Regions of much higher raiding were identified, in addition to heterogeneous distributions by species. Potatoes (Solanum tuberosum), pyrethrum and wood-stock were most affected. Though seasonal patterns in raiding were observed, this did not correlate strongly with rainfall. Several costs stemmed from this crop raiding, including direct expressed monetary loss and development restrictions such as the opportunity costs of guarding crops and reduced dietary diversity. These costs were predominantly felt in central regions of park adjacent land.

6.2.2 Perceived human-wildlife conflict

6.2.2.1 Problem analysis

Aggregation of focus group problem citations revealed that a lack of pesticides and fertilizers was the most prominent issue limiting participants’ livelihoods. This was followed by crop raiding and the government-imposed obligation to grow pyrethrum (fig. 6.3). Comparison between male and female focus group did reveal apparent differences of opinion.

Adjustment of these citations for rank among each focus group’s problem set (ordered through pairwise ranking) revealed the prominence of crop raiding, lack of pesticides and fertilizers, land shortage and obligatory growth of pyrethrum, in descending order (fig. 6.4). The disparity in the problem of crop raiding between both metrics may be explained by the importance of crop raiding as an issue when raised, though this was not consistently highlighted, whereas more ubiquitous limitations to farming systems, such as a lack of land or supplies, were consistently raised but often out-ranked by other issues. In addition, sum-reciprocal rank values revealed a gender divide on the importance of land shortage and pyrethrum, in contrast to basic citation numbers.
Figure 6.3: Distribution of problem citations obtained during the focus group problem analysis protocol. $N = 91$.

Figure 6.4: Visualisation of problem importance, using the sum for each problem of the reciprocal rank value of each citation within focus group problem sets. $N = 91$. 
6.2.2.2 Commonalities in focus group discourse of HWC

Insignificance of gorilla damage

Though raiding of crops by gorillas was identified as an important problem in preliminary investigations and was a major concern of conservation NGOs and National Park management, focus group statements indicated that group perception of this problem was much reduced. In some instances it was expressed that the damage done by gorillas had less overall impact than raiding by other species:

"Gorillas are not a problem for us. They come sometimes and feed on trees, but if my family do not feed on trees, why bother then? But buffaloes feed on what my family relies upon to survive" (S_M, M7)

The economic importance of gorilla tourism, acknowledged vocally by some ("Even gorillas damage our trees but they benefit the country when they track", N_M, M8), may have caused deliberate underreporting of this issue, evidenced by participants of one focus group (R_F, W4) insisting that only buffalo raiding occurs, despite independent observations of extensive gorilla damage to eucalyptus plantations in the area. Alternatively, underreporting of damage could be linked to tree planting being a forced agricultural strategy ("The local leaders mobilise us to plant trees around our houses and plots. We plant trees but gorillas come and feed on them") and not one traditionally adopted. Preliminary investigations revealed that planting ibiti (timber) was limited to wealthier members of the community.

Predominant raiders

The most prominent theme of focus group analysis was the significant, if spatially heterogeneous, levels of buffalo crop raiding. In the majority of focus groups, buffalo were cited as the most damaging species, though rarely the greatest limitation to farming, as shown above. Exceptions to this included Jenda Sector, where no buffalo raiding was reported in focus groups ("We never, never see buffalo in the area", J_M, M1). Focus groups which did not cite buffalo raiding identified limited raiding by other species, including golden monkey, porcupine and bushbuck. Additional to mammalian raiding, insect damage was noted in one focus group account though the claims of complete loss of crops due to this was not corroborated in other focus groups, surveys or field observations.

"... potato pests, because you even plant potatoes but you expect nothing at the period of harvest because pests deteriorate all crops" (N_F, W5)
**Costs of raiding**

Opportunity costs associated with conflict emerged through several focus group accounts. These included the requirement to limit the variety of crops to those less susceptible to raiding, an inability to pay medical insurance as a result of loss, the requirement to guard crops for extended periods of time and the specific loss of employment as a result of crop damage. These problems are analysed further in later sections of this chapter.

### 6.2.3 Extent and range of crop raiding

#### 6.2.3.1 Predicted extent and intensity

The *a priori* predictive surface of crop raiding intensity, based on relationships identified in similar studies of crop raiding, is shown in Figure 6.5. Given that the coarse resolution of population density data reduced the specificity of this model, giving strong delineation along sector boundaries, human population density was excluded from the final *a priori* model. Darker regions represent those areas where crop raiding is expected to occur at higher frequencies, such as regions generally closer to VNP and near to water course ravines. Higher intensity areas near the DRC and Ugandan border, however, are explained by a lack of habitation and infrastructure data for these countries.

![Map of the VNP area showing predicted intensities of crop raiding. Points A, B and C represent regions of unusually high predicted crop raiding.](image-url)
The three marked points on Figure 6.5 represent areas where crop raiding is expected to be higher than predicted through proximity to VNP alone. At point A, though the region is not highly sloped, raiding likelihood is high. Points B and C are located in areas of high slope, with several water courses present.

6.2.3.2 Observed extent and frequency

Overview

Over the 12 month monitoring period, 3,490 raiding events were recorded, occurring in 26 of the 29 park-adjacent cells. This affected the crops listed in Table 6.2, proportionally split by implicated species. Potatoes were most affected (55.25% of total raiding), followed by pyrethrum (18.89%), timber plantations (11.79%), wheat (Triticum spp.) (7%) and maize (2.29%). Minor numbers of raiding accounts on other crops were also reported. In addition to crops, very limited damage to property was reported, perpetrated by elephant.

Table 6.2: Total raiding percentages observed in 2012, divided by crop affected and implicated species.

<table>
<thead>
<tr>
<th>Crop</th>
<th>B</th>
<th>GM</th>
<th>MG</th>
<th>P</th>
<th>BD</th>
<th>E</th>
<th>Bb</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato (Solanum tuberosum)</td>
<td>29.9</td>
<td>14.87</td>
<td>0.2</td>
<td>5.81</td>
<td>2.32</td>
<td>1.28</td>
<td>0.87</td>
<td>55.25</td>
</tr>
<tr>
<td>Pyrethrum (C. cinerariifolium)</td>
<td>18.31</td>
<td>0.36</td>
<td>0.11</td>
<td>0.08</td>
<td>0.00</td>
<td>0.00</td>
<td>0.03</td>
<td>18.89</td>
</tr>
<tr>
<td>Wood-stock</td>
<td>1.23</td>
<td>2.29</td>
<td>6.48</td>
<td>0.64</td>
<td>0.06</td>
<td>1.03</td>
<td>0.06</td>
<td>11.79</td>
</tr>
<tr>
<td>Wheat (Triticum spp.)</td>
<td>6.48</td>
<td>0.14</td>
<td>0.03</td>
<td>0.06</td>
<td>0.20</td>
<td>0.03</td>
<td>0.06</td>
<td>7.00</td>
</tr>
<tr>
<td>Maize (Zea mays)</td>
<td>1.73</td>
<td>0.42</td>
<td>0.00</td>
<td>0.11</td>
<td>0.03</td>
<td>0.00</td>
<td>0.00</td>
<td>2.29</td>
</tr>
<tr>
<td>Bean (Phaseolus vulgaris)</td>
<td>0.45</td>
<td>0.03</td>
<td>0.00</td>
<td>0.06</td>
<td>0.20</td>
<td>0.06</td>
<td>0.03</td>
<td>0.83</td>
</tr>
<tr>
<td>Pea (Pisum sativum)</td>
<td>0.53</td>
<td>0.14</td>
<td>0.00</td>
<td>0.06</td>
<td>0.11</td>
<td>0.00</td>
<td>0.08</td>
<td>0.92</td>
</tr>
<tr>
<td>Bamboo (Arundinaria alpina)</td>
<td>0.11</td>
<td>0.54</td>
<td>0.08</td>
<td>0.00</td>
<td>0.00</td>
<td>0.03</td>
<td>0.00</td>
<td>0.76</td>
</tr>
<tr>
<td>Grass</td>
<td>0.56</td>
<td>0.06</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.62</td>
</tr>
<tr>
<td>Millet (Eleusine coracana)</td>
<td>0.38</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.38</td>
</tr>
<tr>
<td>Cabbage (Brassica oleracea)</td>
<td>0.11</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.11</td>
</tr>
<tr>
<td>Tree Tomato (S. betaceum)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.06</td>
<td>0.00</td>
<td>0.06</td>
</tr>
<tr>
<td>Cauliflower (Brassica oleracea)</td>
<td>0.03</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.03</td>
</tr>
<tr>
<td>Papaya (Carica papaya)</td>
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<td>2.98</td>
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* B = buffalo, GM = golden monkey, MG = mountain gorilla, P = porcupine, BD = black-fronted duiker, E = elephant, Bb = bushbuck
Spatial variation

The number of raiding events per forest-adjacent cell, when controlled for either length of forest-adjacent perimeter or area of cell within 1km of the VNP boundary, was not uniform (fig. 6.6). Notable areas of heightened raiding include Bisoke and Buramba Cells. The low representation of Nyabigoma, though having many raiding events, was explained by its extensive (11km) park perimeter and area within 1km of VNP. Differences between perimeter and area normalisations can be explained by the differing geometries of park adjacent cells.

![Histogram showing variation from west to east in crop raiding incidences per administrative cell, controlled for both length of VNP boundary of each cell and area of each cell lying within 1km of the VNP boundary. N = 3582](image)

*Figure 6.6: Histogram showing variation from west to east in crop raiding incidences per administrative cell, controlled for both length of VNP boundary of each cell and area of each cell lying within 1km of the VNP boundary. N = 3582*

Taking spatial variation at individual point-event scale, density mapping using the Point Density tool in Arc-Map allowed sub-cell patterns to become apparent (fig. 6.7). Clustering at locations within Nyabigoma, Bisoke and Gisizi Cells was observed, which would not have been observed through normalised cell-level analysis. Additionally, proximity of raiding events to the park was significantly skewed (skewness = 2.377) to lower distances (fig. 6.8 a).
Relative point density of crop raiding events

0.06 - 0.77
0.77 - 1.90
1.90 - 3.02
3.02 - 4.14
4.12 - 5.38
5.38 - 6.62
6.62 - 8.34
8.34 - 10.35
10.35 - 12.30
12.30 - 15.02

Shane Mc Guinness: Trinity College Dublin, Ireland

Figure 6.7: Point density visualisation of crop raiding incidences from January - December 2012. Zero raster values excluded from visualisation to improve clarity.

When investigated through Multi-distance Spatial Cluster Analysis in Arc-Map, raiding events were found to be significantly clustered at short distances and significantly dispersed at longer distances (fig. 6.8 b), showing that, though definite patterns exist at smaller scales, the issue of crop raiding is not localised to specific regions of the park boundary. This agrees with the dispersed but non-homogenous distribution observable through point density analysis (fig. 6.7).

Figure 6.8, a-b: Statistical representations of heterogeneity in spatial distribution of crop raiding events. Figure a) shows a histogram of distance to the VNP boundary, with a distribution dominated by close proximity (skewness = 2.377,
kurtosis = 7.777). Figure b) shows the output of Multi-distance Clustering analysis for monitoring data. Distances ranging from 100m minimum, with 50 distance increments of 200m. 9 permutations of random point positioning, with number of random points equalling total of observed points (3,490). Deviation from expected and significance intervals at lower distances indicates significant clustering at low scale. Deviation from expected and significance intervals at higher distances indicates significant dispersal at greater scale.

**Faunal variation**

Table 6.2 lists the proportions of raiding perpetrated by each species, while Figure 6.9 shows the proportions of day and night raiding. Crop raiding by buffalo predominated (60.1%) raiding events throughout 2012, most of which (99%) occurred during the night. Of total raiding proportions, buffalo were followed by golden monkey (19.5%), mountain gorilla (6.9%), porcupine (6.8%), black-fronted duiker (3%), elephant (2.6%) and bushbuck (1.2%). In general, raiding during daylight hours was perpetrated by primates (golden monkey and mountain gorilla) with limited daytime raiding by other taxa (fig. 6.9). Night raiding was dominated by buffalo, elephant, porcupine and black-fronted duiker.

![Figure 6.9: Frequencies of crop raiding per implicated species, showing proportions of night and day raiding. N= 3,582.](image)
Buffalo
Crop raiding by buffalo was found to be widely dispersed across the VNP boundary, with discernible areas of lower or absent raiding rates in Kareba, Gasizi and Nyabigoma Cells (fig. 6.10 a). Proximity to the park boundary was widely varied, ranging from 0 – 2.16 km.

Golden monkey
Golden monkey raiding predominantly affected farmland along the western perimeter of VNP, along the southern and western slopes of Karisimbi Volcano and the eastern slopes of Bisoke Volcano (fig. 6.10 b). Crop damage caused by golden monkey was limited further east than the central saddle of the park.

Mountain gorilla
Mountain gorilla crop damage was exclusively reported in areas east of Karisimbi Volcano, with discernible clustering of accounts in this region (fig. 6.10 c) though frequencies were lower than that of buffalo or golden monkey.

Porcupine
Raiding by porcupine was limited to two defined regions: on the southern and western slopes of Karisimbi Volcano and in regions of park adjacent land under the Gahinga and Muhabura Volcanoes, in the east (fig. 6.10 d). A single account of porcupine raiding in the central region may have been misidentified.

Black-fronted duiker
Duiker raiding was predominantly limited to farmland adjacent to the eastern slopes of Muhabura Volcano, with a single report of black-fronted duiker raiding in Basumba Cell to the east (fig. 6.10 e). This was most likely misidentified.

Elephant
Elephant raiding was solely reported in farmland bordering the central saddle of VNP, between the Karisimbi/Bisoke Volcanoes and the Sabyinyo/Gahinga/Muhabura Volcanoes (fig. 6.10 f). This focussed mainly on two concentrations at either side of the saddle.

Bushbuck
Raiding by this species was detected at low levels across the entire VNP perimeter, with small amounts of clustering in areas near water courses (fig. 6.10 g).
Figure 6.10, a-g: Crop raiding accounts split by species, from January – December 2012, for (a) buffalo, (b) golden monkey, (c) mountain gorilla, (d) porcupine, (e) black-fronted duiker, (f) elephant and (g) bushbuck.

Variation in species assemblage along the perimeter of VNP, from west to east and controlled for area of each cell lying within 1km of the VNP boundary, shows clear regionally-specific problem animals (fig. 6.11). This includes golden monkey raiding in western regions and mountain gorilla crop in central regions. Elephant were also highly localised to eastern central regions. Data for Rega and Karangara, though missing, is most likely similar to that of neighbouring cells.

Figure 6.11: Frequency distribution of crop raiding events across VNP-adjacent cells, and species implicated, controlled by area of each cell within 1km of the VNP boundary. N = 3,582.
**Temporal variation**

Combining all species accounts, raiding activity is significantly skewed towards night-time raiding, owing to the number of buffalo raiding events. Annual comparison showed peaks in raiding during March and June. Overlaying this with seasonal rainfall measurements for northern Rwanda does not show a relationship between wet and dry season and level of raiding (fig. 6.12).

![Figure 6.12: Monthly total raiding events, with overlay of monthly mean rainfall (mm) measurements for northern Rwanda. Rainfall data derived from graphic in McSweeney (2011).](image)

Visualisation of annual patterns in a time series animation (Digital Appendix A – VNP Raiding Time Series; Jan-Dec, 2012) revealed no discernible concentrations of species or locations across the monitored year.

### 6.2.4 Socioeconomic impacts of crop raiding

The socioeconomic impacts of crop raiding were categorised into asset loss, opportunity costs and development costs. Preliminary analyses, focus groups and surveys unveiled significant perceived socioeconomic effects of HWC on park-adjacent communities. These were quantified where feasible. Asset losses and opportunity costs were then visualised spatially to explore discernible heterogeneity.

#### 6.2.4.1 Nature and levels of socioeconomic impacts

**Asset loss**

Park-adjacent farmers expressed considerable concern over asset loss as a result of HWC. Most related to crop loss, either through loss of crops intended for consumption ("Often we grow maize
in big plot but buffaloes come and eat all crops. We plant it to feed the buffaloes”, B_F, W7) or for market sale (“where we expect to get money the buffalo come and eat them”, S_F, WB).

Questioning farmers during survey transects about the weight of crops lost in their most recent raiding event, revealed a mean loss of 148 kg (S.D = 180.3, n = 89). Forecasted financial loss for the year 2013 of those willing or able to estimate (n = 113), normalised for land holding size, is outlined in Figure 6.13.

![Histogram showing the distribution of forecasted loss for 2013 owing to HWC, normalised by each respondents land holding. N = 113.](image)

Figure 6.13: Histogram showing the distribution of forecasted loss for 2013 owing to HWC, normalised by each respondents land holding. N = 113.

One respondent (Nya37.3) claimed to be pressing charges against RDB for damages in excess of 5 million RwF, though the respondent owned 6 ha of land. Information collected during monitoring on surface area damaged (fig. 6.14) yielded a similar distribution to potential loss of yield.

It was not possible to estimate monetary loss of damage events through monitoring, as more detailed assessment of each case would be required to ascertain actual value of crops lost or potential future cost of immature plants destroyed. However, ongoing calculation of estimated damage costs are being derived, using yield models for 2012 (normalised to per m² of cropped area) (MINAGRI, 2012a) and regional crop wholesale prices for that year (RATIN, 2013) to estimate the cost of damage to near-harvest crops.
Limited reference was made to damage of private property throughout all stages of investigation, with minor accounts of historical elephant damage to houses, though this could not be confirmed. A single account was made of a buffalo herd entering the grounds of a tourist lodge (Sabyinyo Silverback Lodge), destroying garden furniture, chalets and injuring a guard. This event also prevented tourists from trekking on that day.

The impact of HWC on social assets was revealed through preliminary interviews and focus groups. It was explained that controversy over crop raiding, demands for compensation and potential relocation of those farming nearest VNP may be labelling these farmers as trouble makers in the eyes of local government or reducing their worth as farmers. Additionally, those benefiting from park revenue sharing were seen as privileged, further lowering the status of those who do not receive revenue sharing payments.

**Opportunity costs**

Human-wildlife conflict and particularly the necessity to actively guard crops (shown to be a prominent mitigation strategy as part of RO4) resulted in several costs to affected households, beyond asset loss.
Firstly, required presence in fields during day and night to guard crops, led to likely reductions in household time, a factor highlighted in other studies (Hill, 2000; Hoare, 2000),

“Sometimes we are passing all the night, out during the night like soldiers” (K_M, M1)

Though in other studies a loss of school attendance and performance was a concern (Kagoro-Rugunda, 2004; Mackenzie and Ahabyona, 2012), respondents in this study claimed that the existence of two daily classes in primary schools allows children to alternate guarding (where necessary) and school. Furthermore, children were not often identified as crop guarders due to safety concerns with larger mammals (fig. 6.29 in RO4).

This continued presence, particularly during the night, is likely to have raised exposure to vector-borne diseases. Personal observations of guarding showed that those employed to guard spend entire nights in the field, either fully exposed to the elements or residing in rudimentary guard huts with no windows or doors.

The effect of HWC on local employment was also noted in administered surveys. This took the form of reduced employment on collective farms as a result of crop raiding. Conversely, for some crop raiding was seen as a positive, as “when there is crop raiding I get a job as a watcher out” (K_M, M4). One account claimed that crop raiding presents both a problem and source of employment, in the circular argument that when crops are damaged “there is no job for harvesting or watching out for buffaloes” (N_M, M5). This highlights the often contradictory perceptions expressed of HWC and its opportunity costs.

**Development costs**

Though VNP management expressed in preliminary meetings a commitment to continued development of park-adjacent communities, further investigation through focus groups and administered surveys revealed that HWC has imposed several limitations to regional sustainable development.

**Dietary diversity**

Anecdotal accounts given in focus groups showed that the diversity of edible crops has decreased in living memory as a result of crop raiding by forest-dwelling animals;

“We grow peas in years ago but now no more peas. Instead we grow fruits, because buffalos were eating all pea crops and we found it useless to keep growing” (K_F, W5)

“We used to plant beans, peas, maize and wheat but due to crop raiding we are no longer growing these. Because we cannot get anything after, as buffaloes will damage all these” (K_M, M2)
This theme reflects the findings of previous studies, where gross harvests and varieties of crops have fallen as a result of HWC (Ogra, 2008).

Vision 2020 targets of increased agricultural export and reduced subsistence-level agriculture (RoR, 2000) have manifested as increasing pressure to interact with a market economy, resulting in 96% (n = 173) of respondents now selling a portion of their harvest. Though it was hoped that this would compensate for reduced dietary diversity as a result of crop raiding, surveys revealed that few respondents have independent access to their local market, with most (90%, n = 157) relying on the owner of a vehicle. It was claimed that vehicle owners impose artificially low roadside prices;

“The lack of a market is caused by very bad roads in our area and therefore not many cars and lorry can access our communities to get that good price we need. The few cars that come fix the price and we become vulnerable because of the poor infrastructure. Secondly we don’t have transport means to bring our harvest in the town or a way to get the good price” (B_F, W7).

Restrictions on crop mixing and crop choice detailed in Section 6.3.2 of this chapter, coupled with restricted market access, is likely to result in heavier HWC impacts at a household level.

Health insurance
Cited several times through focus groups and surveys was a perceived inability to pay contributions to the mandatory national health insurance scheme, Mutuelle de Santé, as a result of losses incurred through crop raiding.

“Sometimes (buffalo) can come and fully feed and damage all plots you grow. From these how can you survive? How can you pay the medical insurance?” (S_M, M6)

In some cases this necessitated borrowing from local lenders or family, a financial strain previously identified by NGO representatives (G. Daconto, CARE International, 09/02/11).

This was also related to local price controls on produce;

“We can be able to pay the Mutuelle de Santé if we have a good price” (R_M, M3)

Batwa
An unexpected socioeconomic consequence of crop raiding was the exacerbation of animosity towards formerly forest-dwelling people, the Batwa, arising through attribution of blame for damages. This theme emerged in focus groups, where strong anti-batwa sentiments were expressed;
“(The Batwa) are not good, because they come in our fields and steal our crops, they were dependent on the forest before but now they do nothing more than coming in our crops and stealing” (B_F, W6)

During Tourism and Conservation development meetings the batwa were similarly accused of begging and deterring tourists, though it was thought that their “potentially-interesting culture” (JADF, 22/09/11) may be exploited for tourism gains. This was further reflected in administered surveys, where 89% (n = 160) of respondents saw this community as negatively impacting the forest.

“These people are not ready to forget hunting. They don’t farm and they are thieves” (Jen7.2),

“They are people like us themselves, but they will hunt, especially if they live near the forest.” (Bug6.1)

### 6.2.4.2 Geographic variation of socioeconomic effects

![Map visualising the loss incurred through crop raiding within 1 km of the park boundary, as measured through area damaged, using inverse distance-weighted (IDW) interpolation between monitoring records in Arc-Map. Figures are log-transformed owing to the large range of damage records.](image-url)
Asset loss

Though previous visualisations revealed spatial heterogeneity in raiding frequencies, inverse distance-weighted (IDW) interpolation of area damaged as measured throughout monitoring data revealed heterogeneity in the socioeconomic effects of crop raiding (fig. 6.15). This IDW layer was clipped to a 1km buffer of VNP as too few events were recorded beyond this distance, reducing the descriptive value and relevance of interpolation beyond this distance.

Areas of high damage can be seen in farmland on the eastern slopes of Karisimbi and Biseke Volcanoes (A, in Figure 6.15), the central saddle (B) and the southern slopes of Sabyinyo and Gahinga Volcanoes (C). Though points B and C correspond to areas of heightened raiding frequency (fig. 6.7), point A does not. Similarly, western regions of the VNP boundary, while displaying high raiding frequency, showed comparatively low levels of damage.

Expenditure on HWC mitigation through employing a guard was found to be higher in central regions (fig. 6.16). Correlation analysis did not show a relationship between expenditure and distance to the VNP boundary ($R^2 = 0.0157$), nor did normalisation of this for size of land holding ($R^2 = 0.0407$).

Figure 6.16: Map showing expenditure on crop guarding mitigation per month, as reported by survey respondents. Colouration is based on 10-quantile divisions for clearer visualisation of range. N = 180.
Opportunity costs

Though not found to affect school attendance, child guarding may affect school performance and may have health implications, such as increased exposure to infectious diseases. The spatial distribution of reported child guarding is shown Figure 6.17, depicting concentrations of child guarding of park-adjacent farmland in the central saddle and western regions. Western regions are exposed to higher golden monkey raiding, against which children can effectively guard. It is unclear, however, why child guarding is additionally prominent in central regions where raiding by buffalo, elephant and gorilla predominates.

![Map showing the survey respondents who claim to use children to guard crops. Survey transects are shown as red lines, within the forest-adjacent sample sectors in grey. n = 22.](image)

**Figure 6.17:** Map showing the survey respondents who claim to use children to guard crops. Survey transects are shown as red lines, within the forest-adjacent sample sectors in grey. n = 22.

6.3 RO2 – Establish the likely determinants of conflict, including spatiotemporal variation

This research objective was addressed using 1) the findings of preliminary investigation, focus groups and administered surveys to build a qualitative picture of crop raiding, local perceptions of the issue and likely determinants and 2) the 12-month monitoring data set to build a robust model explaining the variability in raiding across space and the influence of individual factors on this.
6.3.1 Summary
Perceived crop raiding corresponded to periods of increased crop planting. In addition, gender was found to influence perceptions of conflict. Shortages of land and restrictions on its use were raised as exacerbating conflict, with particular focus on the role of agro-industry. Ecological factors affecting crop raiding intensity were well understood locally, such as a rise of within-park animal numbers and seasonal shortages of forest forage. Proximity to the VNP boundary dictated both the levels of raiding and the suite of implicated species. Logistic regression confirmed that perceived exposure to crop raiding was strongly influenced by land tenure, control of agriculture and distance to VNP. Although multivariate modelling of monitoring data did not yield significant explanatory power, spatial variation in the residuals of this model suggest that spatial non-stationarity of these and omitted variables may be at play.

6.3.2 Preliminary investigation, focus group and administered survey findings

6.3.2.1 Agricultural determinants

Crops grown
Focus group assessment of crop raiding revealed that potatoes, maize, peas and beans are the most susceptible to crop raiding, though it was claimed that the latter two are no longer cultivated in significant proportions due to their vulnerability. The three-month rotation of crops, with the exception of pyrethrum (an annual crop) and the planting of wood-stock (life cycle exceeding 10 years), means that the planting time of crops does not necessarily correspond to times when the most benefit would be gained by forest-dwelling animals from raiding such crops, such as times of low forest forage availability.

Combining crop planting proportions across focus groups yielded the cropping calendar shown in Figure 6.18. The year-round cultivation of potatoes, as claimed in focus groups and preliminary investigations, was apparent, in addition to the annual planting of pyrethrum, being exclusively planted from January to May, with a peak in March and April. Wheat is planted in two defined periods; from February to April and from October to November. Maize and beans are planted throughout the year. When perceived crop raiding intensity was overlaid on this, a relationship was observed between periods of increased crop planting and heightened perceived crop raiding.

This does not appear to correspond with the planting of more susceptible crops, however, for example maize ("Often we grow maize in big plot but buffaloes come and eat all crops. We plant it to feed the buffaloes", B_F, W7). In general, more raiding is claimed to occur during months when
increased planting takes place, potentially indicative of the link between farmers' presence in fields and perceived levels of crop raiding.

Figure 6.18: Combined seasonal crop planting patterns (primary x-axis), measured through group consensus on a scale of 1-5 in each of 12 focus groups. The magnitude of perceived annual crop raiding is overlaid (secondary x-axis). Fruit refers to papaya, tree tomatoes and passion fruits.

**Gender**

Division by gender of perceived monthly levels of crop raiding, as expressed in focus groups and transformed based on problem set size and ranking, yielded a significant difference in perception \( t(11) = 7.097, p < 0.05 \) as shown in Figure 6.19. This showed consistently higher ranking of crop raiding as a problem by male focus group participants than that of female participants.

Figure 6.19: Line graph showing trends in perceived magnitude of crop raiding, as expressed in focus groups. Paired two-tailed T-test revealed a significant difference between male and female perceptions.
Land shortage
Division of land through inheritance was highlighted as a significant limitation to land availability. This was reflected in surveys through a mean reported land holding of 0.73 ha (SD = 0.9), with a distribution highly skewed (3.69, p = 0.181) towards smaller plots. This figure for mean land holding was also affected by a small number of very large landowners. Despite 99% of respondents claiming to own at least one plot, it emerged that land rights in most VNP-adjacent areas are currently based on long-term leases from government controlled land. As such, ownership or autonomy is not guaranteed and is widely ambiguous. Additionally, much animosity towards the current government land registration programme was expressed. It was strongly claimed that these practices have exacerbated the effect of conflict with park animals, through regional limitations on growing crops close to the forest edge, particularly in light of restricted use of forest-based resources;

“We don’t have enough land as it’s shared with the children” (Bug5.4)

Agro-industry
The proportions of land controlled by agro-industry and required to be planted with pyrethrum have been strictly enforced, despite division of land parcels through inheritance (Sopyrwa source, 2013, pers. comm. 20th Feb). It was claimed across all methods that this is leading to increasing land pressure and difficulty in growing food crops, increasing the livelihood impact of crop raiding events when they do occur. Food shortages as a result of pyrethrum cultivation were regularly expressed in surveys. Of those asked, 77% were obliged to grow pyrethrum, though 87% of these disagree with the policy. Most claimed that lucrative revenue generated from the industry is not equitably shared, while claiming that policies to ensure cultivation are coercive and include blackmail;

“It’s the law. If you don’t grow ibireti (pyrethrum) you lose your land.” (Jen7.1)

This policy was confirmed by a Sopyrwa official who claimed that “sometimes coercion is required, as these are little people” (Sopyrwa source, 2013, pers. comm. 20th Feb.). Furthermore, personal observations of intimidation, propagation of fear and threats were observed while on field transects. Concern was expressed over the time required to grow this crop, equivalent to three growing seasons of other tubers and legumes, while most (90.5%) claim that forced growing of pyrethrum has reduced household income;

“They say it’s to develop us but we see it as increasing our poverty” (Shi14.2)
Agricultural autonomy

The lack of autonomy as a result of government-driven land-use consolidation was reflected strongly in focus group discussions, with 87% of survey respondents claiming not to have control over farming practices. Most stated that threats have been made to ensure compliance;

"How can you refuse? They will throw you out." (Shi13.1)

"They ask us to grow it. If we do not they take away our land." (Jen11.2)

Preliminary investigations revealed that the mixing of crops had been a traditional coping mechanism against crop raiding and in times of poor productivity. Of those surveyed, however, 90.5% no longer intercrop. It was expressed that standardisation of cropping requires farmers to sell surpluses to local markets, though only 8.6% of respondents could do so independent of intermediary transport. Strong animosity was further expressed towards government policy, with claims of food shortages and reduced dietary diversity, with particular discontent over a lack of consultation throughout;

“There is hunger because we are not using our land to grow peas and maize. We are forced.” (Kin31.4)

“There was no consultation. We are growing what we don’t need.” (Nya36.1)

Requirements for high intensity agriculture were further claimed to increase the need for fertiliser, either organic or mineral, and pesticides. This issue was prominent throughout pairwise problem analysis in focus groups, surpassed only by crop raiding and land shortages. Several respondents additionally expressed concerns over the highly regulated distribution and vending of these resources;

“If we dare to go to buy fertilizers to the other sector, our sector leader refuses to allow fertilizers from other sectors to come to be used in our sector. We are only allowed to get fertilizers in (these) shops” (R_F, W8)

Regional population pressure was also highlighted by focus group participants and key informant interviews as exacerbating the effects of conflict through associated resource shortages, including arable land and water. This combination of land shortages, agroindustry interventions and government land-use consolidation was thought to exacerbate the effects of HWC crop losses incurred.
6.3.2.2 Ecological determinants

Fauna

Though not quantified by the current study, within-park distributions of certain potentially-raiding species were approximately understood by conservation NGOs and VNP management, based on locations of golden monkey and mountain gorilla groups used for tourism and research purposes. This was claimed to affect regional raiding intensities of these species. Distributions of buffalo, elephant, porcupine and other species were not known. The populations of these animals were claimed to be increasing in general, while accurate census numbers for mountain gorilla shows an increase in their numbers (Robbins et al., 2011). Several focus group accounts cited successful conservation and increased restrictions on park use as drivers of these increases;

“In the past there were hunters, but now we are not allowed to hunt” (Shi12.3).

The ecological understanding of potential drivers of conflict was high among focus group and survey participants alike. Several recognised that seasonal shortages of forest forage were causing animals to range outside VNP;

“Buffalo lack enough food resources in the park and that pushes them to come and get more outside to satisfy their food security” (B_F, W8)

Furthermore, it was claimed that crops on the forest’s outskirts are more easily attainable than forest forage and would be preferred to it. Accounts from surveyed farmers suggested that periods of heavy rain, with increased abundance of forest forage, led to reduced raiding. This conflicted with accounts given by conservation workers, claiming that the presence of mountain gorilla and golden monkey along the park boundary, leading to increased raiding, may be dictated by increased availability of young bamboo shoots at lower altitudes (i.e. closer to the forest edge) during wet seasons.

Location

Though not expressed in focus groups as a determinant of conflict, proximity to the park was assessed in survey transects, as a prescribed factor from previous studies (Naughton-Treves, 1998; Hill, 2000; Kagoro-Rugunda, 2004). Perceptions of raiding species assemblages were found to vary with proximity to the park, showing a general decrease in reported raiding with increasing distance from the park boundary (fig. 6.20). Buffalo raiding represented a larger proportion of raiding at greater distances, while golden monkey and mountain gorilla raiding decreased with increasing distance.
The inadequacy of defences in certain areas along the VNP margin was highlighted as an important determinant of conflict by focus group participants. Though improvements in wall quality and maintenance were requested, there was recognition that a well-maintained dry-stone wall would still not deter primates;

"Monkeys are dangerous. They climb so that we cannot do anything to protect our crops."

(J_F, W1)

Expressed limitations to these improvements included cost, availability of raw materials and labour, and the inaccessibility of certain areas.

Slope was cited as a determinant of raiding, due to difficulties in maintaining defences and in allowing fauna to see over stone walls to crops (Kabatwa village meeting, 08/02/11). Personal observations of high slope park-adjacent areas confirmed these difficulties in wall maintenance. Additionally, soil fertility and depth in these regions seemed higher than often over-cultivated flatter land, allowing more intensive agriculture with vulnerable crops.

6.3.2.3 Binary logistic modelling of determinants

Testing the significance of potential determinants of surveys respondents’ experiences of conflict, using binary logistic modelling, was carried out following derivation and modification of variables
outlined in the Chapter 5 (Methods: Data Collation and Analysis) of this thesis. The variable accounting for market access was excluded from the initial model due to redundancy. Backward-elimination of variables using the Wald statistic yielded 11 models of varying predictive power and parsimony. Testing the goodness of fit of these models using Akaike’s Information Criterion (AIC) showed that model 7, containing 9 of the original 16 variables, was the best performing compromise of predictive power and parsimony (Table 6.3), displaying a predictive accuracy of 75.4%, while accounting for 28.7% of model variation (Nagelkerke’s $R^2 = 0.278$). A Hosmer and Lemeshow Test further indicated that the model was likely to accurately predict a farmer’s perceived exposure, given the set of criteria included in the model (d.f. = 8, p =0.798).

Table 6.3: Model summary of binary logistic regression, testing for determinants of experiencing or not experiencing crop raiding. Optimal model results are shown in bold.

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<td>187.140</td>
<td>3.921</td>
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<td>.864</td>
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<tr>
<td>2</td>
<td>14</td>
<td>74.3</td>
<td>90.8</td>
<td>31.9</td>
<td>157.144</td>
<td>.219</td>
<td>.315</td>
<td>185.144</td>
<td>6.629</td>
<td>8</td>
<td>.577</td>
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</tr>
<tr>
<td>3</td>
<td>13</td>
<td>73.7</td>
<td>90.8</td>
<td>29.8</td>
<td>157.166</td>
<td>.219</td>
<td>.315</td>
<td>183.166</td>
<td>8.835</td>
<td>8</td>
<td>.356</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>74.3</td>
<td>91.7</td>
<td>29.8</td>
<td>157.205</td>
<td>.219</td>
<td>.315</td>
<td>181.205</td>
<td>9.595</td>
<td>8</td>
<td>.295</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>11</td>
<td>74.3</td>
<td>91.7</td>
<td>29.8</td>
<td>157.348</td>
<td>.218</td>
<td>.314</td>
<td>179.348</td>
<td>5.226</td>
<td>8</td>
<td>.733</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>74.9</td>
<td>92.5</td>
<td>29.8</td>
<td>157.530</td>
<td>.218</td>
<td>.313</td>
<td>177.530</td>
<td>6.112</td>
<td>8</td>
<td>.635</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>75.4</td>
<td>92.5</td>
<td>31.9</td>
<td>161.324</td>
<td>.200</td>
<td>.287</td>
<td>179.324</td>
<td>4.614</td>
<td>8</td>
<td>.798</td>
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<tr>
<td>8</td>
<td>8</td>
<td>74.9</td>
<td>91.7</td>
<td>31.9</td>
<td>161.705</td>
<td>.198</td>
<td>.284</td>
<td>177.705</td>
<td>5.709</td>
<td>8</td>
<td>.680</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>7</td>
<td>74.3</td>
<td>91.7</td>
<td>29.8</td>
<td>162.672</td>
<td>.193</td>
<td>.278</td>
<td>176.672</td>
<td>4.620</td>
<td>8</td>
<td>.797</td>
<td></td>
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<tr>
<td>10</td>
<td>6</td>
<td>73.7</td>
<td>90.8</td>
<td>29.8</td>
<td>165.375</td>
<td>.180</td>
<td>.259</td>
<td>177.375</td>
<td>4.502</td>
<td>8</td>
<td>.809</td>
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<tr>
<td>11</td>
<td>5</td>
<td>74.3</td>
<td>90.8</td>
<td>31.9</td>
<td>167.443</td>
<td>.170</td>
<td>.244</td>
<td>177.443</td>
<td>4.885</td>
<td>8</td>
<td>.770</td>
<td></td>
</tr>
</tbody>
</table>

a. Akaike’s Information Criterion (AIC) = -2 Log Likelihood +2k, where k is the # of predictor variables in each model d.f. = Degrees of freedom

Significant factors in determining a respondent’s perceived exposure to raiding were identified as distance to the forest boundary (Distance), whether a person owns land or not (Ownership), whether a respondent has the freedom to choose what is grown (Whochooses), time spent
collecting water (Water) and whether the respondent grows pyrethrum or not (Pyrethrum). This was based on the significance levels of the factors in the most parsimonious model (Table 6.4). The categories presented for Whochooses (freedom, government, Sopyrwa) were individually compared to the reference category of having complete freedom to choose crops. Thus, comparison of Sopyrwa-directed (Whochooses2)) cropping with the reference category of self-determination proved the most significant (Table 6.4).

Table 6.4: Variables in the most parsimonious and explanatory model permutation.

<table>
<thead>
<tr>
<th>Variables in the Equation</th>
<th>B</th>
<th>Standard error</th>
<th>Wald Statistic</th>
<th>d.f.</th>
<th>Significance</th>
<th>Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-.020</td>
<td>.013</td>
<td>2.479</td>
<td>1</td>
<td>.115</td>
<td>.980</td>
</tr>
<tr>
<td>Hshld.Size</td>
<td>0.57</td>
<td>.060</td>
<td>.905</td>
<td>1</td>
<td>.342</td>
<td>1.059</td>
</tr>
<tr>
<td>Plotsize</td>
<td>0.000</td>
<td>0.000</td>
<td>.358</td>
<td>1</td>
<td>.550</td>
<td>1.000</td>
</tr>
<tr>
<td>Distance</td>
<td>-.002</td>
<td>.001</td>
<td>8.376</td>
<td>1</td>
<td>.004</td>
<td>.998</td>
</tr>
<tr>
<td>Ownership</td>
<td>-1.603</td>
<td>.750</td>
<td>4.561</td>
<td>1</td>
<td>.033</td>
<td>.201</td>
</tr>
<tr>
<td>Whochoosesb</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whochooses(1)</td>
<td>-1.354</td>
<td>.722</td>
<td>3.518</td>
<td>1</td>
<td>.061</td>
<td>.258</td>
</tr>
<tr>
<td>Whochooses(2)</td>
<td>-1.891</td>
<td>.829</td>
<td>5.205</td>
<td>1</td>
<td>.023</td>
<td>.151</td>
</tr>
<tr>
<td>Water</td>
<td>-.012</td>
<td>.004</td>
<td>7.428</td>
<td>1</td>
<td>.006</td>
<td>.988</td>
</tr>
<tr>
<td>Pyrethrum</td>
<td>1.321</td>
<td>.632</td>
<td>4.374</td>
<td>1</td>
<td>.036</td>
<td>3.747</td>
</tr>
<tr>
<td>Seas.crop.val</td>
<td>.000</td>
<td>.000</td>
<td>2.391</td>
<td>1</td>
<td>.122</td>
<td>1.000</td>
</tr>
<tr>
<td>Constant</td>
<td>2.905</td>
<td>.906</td>
<td>10.273</td>
<td>1</td>
<td>.001</td>
<td>18.267</td>
</tr>
</tbody>
</table>

a. Variables entered on step 1: Gender, Age, Hshld.size, Socio.cat2, Residence, Plotsize, Distance, Ownership, Cropchoice, Whochooses, Sopyrwa.infl, Water, Intercrop2, Pyrethrum, Seas.crop.val.

b. First categorical factor is used as the reference, to which other categorical factors are compared.

B = Coefficient, or intercept, of the variable
Cl = Confidence Interval
d.f. = Degrees of freedom

Subsequently, an ROC (Receiver Operating Characteristic) analysis was conducted, to compare the probability of experiencing crop raiding, as predicted by this model, versus observed binary responses. This yielded an area under the curve of 0.766 with 95% confidence interval (0.689, 0.842) (Table 6.5), which significantly differs from 0.5 (p = 0.000), meaning the logistic regression classifies the group better than by chance (fig. 6.21).
Table 6.5: Area under the Receiver Operating Characteristic (ROC) curve

<table>
<thead>
<tr>
<th>Area Under the Curve</th>
<th>Area Under the Curve</th>
<th>Std. Error</th>
<th>Asymptotic Sig.</th>
<th>Asymptotic 95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>.766</td>
<td>.039</td>
<td>.000</td>
<td>.689</td>
<td>.842</td>
</tr>
</tbody>
</table>

a. Under the nonparametric assumption  
b. Null hypothesis: true area = 0.5

Figure 6.21: ROC curve of binary logistic regression model. The observed curve (blue line) significantly deviates from that predicted by chance (green line).

6.3.3 Multivariate modelling of monitoring data

Preliminary bivariate regressions were carried out to assess levels of collinearity among variables potentially-explaining levels of damage done in m$^3$ per raiding event. Those variables displaying high collinearity were excluded from the final model run. Ordinary Least Squares regression, using the variables (Table 6.7), was subsequently run in Arc-Map, the diagnostics of which are shown in Table 6.6.
Table 6.6: Diagnostics results from Ordinary Least Squares regression analysis.

<table>
<thead>
<tr>
<th>Diagnostic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akaike’s Information Criterion</td>
<td>13013.826</td>
</tr>
<tr>
<td>R² (adjusted)</td>
<td>0.178</td>
</tr>
<tr>
<td>Koenker (studentised Breusch-Pagan) statistic</td>
<td>90.816*</td>
</tr>
<tr>
<td>Jarques-Bera statistic</td>
<td>74.023*</td>
</tr>
</tbody>
</table>

* denotes significance at 0.05 confidence interval.

A The adjusted form of Akaike’s Information Criterion is not required here, as the sample size is not prohibitively small (n = 3,490).

Koenker statistic: Significance suggests non-stationarity in relationships and requires use of robust variable probabilities

Jarques-Bera statistic: Significance suggests non-normal residual distribution

Though all remaining variables were significant, even under robust figures, and redundancy was not present (Table 6.7), the model was not found to adequately explain the variation in damage done to crops (R² = 0.178), indicating that an important variable was missing from the model.

Residuals were found to follow a normal distribution, while mapping of residual standard deviations showed clustering of values, as shown by the red and blue concentrations in Figure 6.22. Ordinary Least Squared results thus suggested that spatial autocorrelation was likely affecting the explanatory power of this model. That is, relationships between variables dictating crop damage are affected by location.

Table 6.7: Variable significance results for Ordinary Least Squares regression analysis. Figures in parentheses represent Standard Errors of coefficients.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Probability</th>
<th>Robust probability ^</th>
<th>Variance Inflation Factor ^</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Mass</td>
<td>0.129 (0.015)</td>
<td>0.000</td>
<td>0.000</td>
<td>1.431</td>
</tr>
<tr>
<td>Elevation</td>
<td>-0.001 (0.000)</td>
<td>0.000</td>
<td>0.000</td>
<td>1.269</td>
</tr>
<tr>
<td>Wall quality</td>
<td>0.129 (0.031)</td>
<td>0.000</td>
<td>0.000</td>
<td>1.256</td>
</tr>
<tr>
<td>Slope</td>
<td>0.012 (0.006)</td>
<td>0.032</td>
<td>0.025</td>
<td>1.319</td>
</tr>
<tr>
<td>Month</td>
<td>-0.04 (0.008)</td>
<td>0.000</td>
<td>0.000</td>
<td>1.005</td>
</tr>
<tr>
<td>Log Distance to park</td>
<td>0.191 (0.018)</td>
<td>0.000</td>
<td>0.000</td>
<td>1.485</td>
</tr>
<tr>
<td>Log Distance to river</td>
<td>0.152 (0.022)</td>
<td>0.000</td>
<td>0.000</td>
<td>1.622</td>
</tr>
<tr>
<td>Log Distance to road</td>
<td>0.161 (0.018)</td>
<td>0.000</td>
<td>0.000</td>
<td>1.172</td>
</tr>
<tr>
<td>Log Distance to Ravine</td>
<td>-0.157 (0.032)</td>
<td>0.000</td>
<td>0.000</td>
<td>1.732</td>
</tr>
<tr>
<td>Log Distance to Hole</td>
<td>0.075 (0.025)</td>
<td>0.003</td>
<td>0.003</td>
<td>1.308</td>
</tr>
</tbody>
</table>

^ Under a condition where the Koenker probability is significant, only robust variable probabilities should be used.

This measures the degree to which variables are collinear, by testing the change in variance through exclusion of a single variable from a separate model iteration. Factors below 7.5 indicate no variable redundancy.
6.4 RO3 – Determine the impacts of HWC on VNP tourism and conservation

This research objective was addressed through analysis of preliminary investigations, focus groups and administered surveys. Data were re-aggregated and triangulated to expand on prescribed and emergent themes of the impacts of HWC on tourism and conservation.

6.4.1 Summary

Though sharing of tourism revenue from VNP was extensive, this was not found to be reaching those most at risk from crop raiding losses and is regulated through the cooperative system. Community support for revenue sharing initiatives was limited, inequitable employment opportunities resulted in frustration and most argued for increased VNP investment in farming and livestock. Despite this, support for tourism was high, through acknowledgement of national financial gain. Support for conservation was low, however, with responsibility being imposed by local leaders. While RDB were predominantly regarded as being solely responsible for VNP, perceptions of positive conservation actions by RDB were limited mainly to employment of guards.
and construction of boundary defences. Strong dissatisfaction was expressed with their support for park-adjacent communities. The value of park ecosystem services was widely understood, as were the ecological drivers of conflict with VNP. Finally, though use of the forest was widely admitted, this was limited to water collection at defined times.

6.4.2 Prescribed themes

Following review of the literature surrounding HWC globally, support for tourism, the sharing of benefits of this tourism and the perceptions to conservation efforts were identified as important prescribed themes.

6.4.2.1 Tourism and revenue sharing from VNP

Preliminary discussion with the management of VNP revealed that sharing of tourism revenue does occur in the form of direct payments. Management claimed that 5% of revenue has been contributed to all communities living adjacent to the three Rwandan national parks. Of this demarcation, 40% is streamed to VNP-adjacent communities, while equal 30% divisions are directed to revenue sharing initiatives around Nyungwe and Akagera NPs. In 2010, revenue sharing around VNP equated to 88 million RwF (circa. US$ 135,300), disbursed through the streams outlined in Table 6.8. The equivalent figure for 2011 equates to over 113 million RwF (circa. US$ 173,700), an increase of 28.4%. This is most likely in line with a 200% increase in visitor numbers from 2003 - 2010, a 100% increase in individual tourist gorilla permits and the increase in popularity of non-gorilla related permits, which are not currently limited (P. Uwengeli, 2011, pers. comm. 18th January). Of note is the policy of disbursing revenue through support for cooperatives and through direct infrastructural investment. This reflects the expressed policy of VNP management not to distribute revenue sharing as cash payments to individuals.

Table 6.8: Revenue sharing from centralised tourism revenue to communities around VNP during 2010. Data source: Community Conservation Warden, VNP.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Organisation</th>
<th>Use</th>
<th>Infrastructure (RwF)</th>
<th>Other (RwF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyanika</td>
<td>Mugarama Primary School</td>
<td>Latrines</td>
<td>4,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kashinge co-operative</td>
<td>Seeds multiplication - potatoes</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rebakure (Intofanyi) co-operative</td>
<td>Seeds multiplication - potatoes</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rugarama Karangara &amp; Cyahi Primary Schools</td>
<td>Latrines</td>
<td>4,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nyamirango co-operative</td>
<td>Agriculture - potatoes</td>
<td>1,500,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ubushake co-operative</td>
<td>Livestock</td>
<td>1,500,000</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Co-operative/Project / Sector</td>
<td>Activity</td>
<td>Budget (USh)</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------</td>
<td>----------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td>Twivanemubukene</td>
<td>Agriculture - potatoes</td>
<td></td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td>Gahunga</td>
<td>Sector infrastructure</td>
<td>Houses - HMP*</td>
<td>5,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Muhabura co-operative</td>
<td>Agriculture - potatoes</td>
<td>500,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Abatiganda co-operative</td>
<td>Store - potatoes</td>
<td>1,500,000</td>
<td></td>
</tr>
<tr>
<td>Nyange</td>
<td>KOTINYA co-operative</td>
<td>Women crafts + Livestock</td>
<td>2,000,000</td>
<td></td>
</tr>
<tr>
<td>Kingi</td>
<td>ANICO co-operative</td>
<td>Seeds multiplication - potatoes</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>KOTIMU co-operative</td>
<td>Mushroom production</td>
<td>2,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sabyinyo II co-operative</td>
<td>Livestock (Sheep)</td>
<td>1,500,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sabyinyo I co-operative</td>
<td>Livestock (Rabbits)</td>
<td>500,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Iteganyirize co-operative</td>
<td>Arts - carpentry</td>
<td>1,500,000</td>
<td></td>
</tr>
<tr>
<td>Shingiro</td>
<td>Sector Infrastructure</td>
<td>Houses - HMP*</td>
<td>12,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>KOTISHI co-operative</td>
<td>Store - potatoes</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bisoke I co-operative</td>
<td>Livestock (Sheep)</td>
<td>500,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bisoke II co-operative</td>
<td>Livestock (Sheep)</td>
<td>500,000</td>
<td></td>
</tr>
<tr>
<td>Gataraga</td>
<td>Sector Infrastructure</td>
<td>Houses - HMP*</td>
<td>9,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mudakama co-operative</td>
<td>Livestock (Sheep)</td>
<td>500,000</td>
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<td></td>
<td>Munyinya co-operative</td>
<td>Livestock (Sheep)</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td>Jenda</td>
<td>Sector Infrastructure</td>
<td>Agroforestry</td>
<td>3,000,000</td>
<td></td>
</tr>
<tr>
<td>Bigogwe</td>
<td>Basumba Primary School</td>
<td>Latrines</td>
<td>4,000,000</td>
<td></td>
</tr>
<tr>
<td>Kabatwa</td>
<td>Kabatwa I co-operative</td>
<td>Agriculture - potatoes</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kabatwa II co-operative</td>
<td>Commerce - fertilizers</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td>Bugeshi</td>
<td>Bulingo Primary School</td>
<td>2 Classrooms</td>
<td>8,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kinyamuhanga co-operative</td>
<td>Agriculture - potatoes</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kabingo co-operative</td>
<td>Livestock - Goats</td>
<td>1,000,000</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>64,000,000</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>24,000,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

*HMP = Historically-marginalised people, a.k.a. Batwa

Additional shared tourism revenue from VNP arises through a private lodge and cultural organisation; Sabyinyo Silverback Lodge (a public-private partnership involving the Governors Camp tourism company and the SACOLA residents’ cooperative) and the Iby’Iwacu Cultural Village Cooperative. Public meetings and private discussions revealed that considerable pressure is applied on both organisations to share revenue generated with other park-adjacent cooperatives, through "inter-cooperative revenue sharing" (Community Conservation Teams Refresher Course, 21/09/11), though informal discussion with the manager of Iby’Iwacu revealed that revenue for this initiative is minor. In subsequent meetings, SACOLA were encouraged to contribute 100
million RwF in 2012, almost equalling claimed VNP revenue sharing for the entirety of 2011. Both organisations subsequently refused to reveal their membership during a Community Conservation Teams Refreshers course, a point criticised by the Community Conservation Wardens of VNP in the same meeting.

Informal discussion with local residents revealed initial discontent with the level of personal gain from revenue sharing, with most blaming a restrictively-bureaucratic cooperative system. Public meetings confirmed this, with expression of literacy and access limitations associated with cooperative establishment, while it was stressed by VNP representatives in these meetings that funds would not be distributed to unofficial cooperatives. This has generated animosity in park-adjacent communities;

> "Following the success of community conservation efforts and associated returns from revenue sharing, there is now emerging conflict between those within cooperatives who benefit and those not members who do not benefit" (Community Conservation Warden, VNP)

Furthermore, it was claimed by some cooperative leaders that the use of revenue donated to these organisations is dictated by RDB, while concern was expressed by individual farmers over the restrictive operating practices of one cooperative in particular (Unicopav, an apiculture association). These concerns surrounding the cooperative hierarchy were echoed by the regional director of CARE International;

> "I don't know whether cooperatives are the right strategy. But in Rwanda now everything must be a cooperative.... These guys with their performance contracts that have to show how many cooperatives they have started. But the cooperative has two different possible things. And one may not be suitable to all things.... the fact that these guys call themselves a cooperative is an institutional problem" (G. Daconto, CARE International)

Several accounts also highlighted the uneven distribution of cooperatives benefiting from revenue sharing schemes, with recognition that those sectors supporting high tourist numbers were receiving most shared revenue. An employee of DFGFI recognised that this may result in increased forest use;

> "Many (water) tanks are only in Kinigi. But in Sector 4, there is nothing. The reason people on Shingiro, Sector 3, Sector 4, they enter always in the park, looking for water in the dry season. Why? No tanks" (DFGFI source).

Associated uneven National Park employment was also raised as potentially reducing support for tourism activities;
"The rangers and trackers; 99% are from Kinigi.... And if there are two or three or four persons in this sector (Gataraga) it's easy for us to mobilise the people (to conserve). But there is one, only one." (DFGFI source)

A Joint Action Development Forum for Tourism and Conservation (JADF) meeting highlighted the lack of control of some tourism services outside VNP;

"Some hotel managers ignore their relationship between their enterprises and VNP" (Participant of JADF, Musanze, 22/09/11).

With direct regard to conflict between communities and VNP fauna, delegates of the JADF raised concerns over HWC. Though a lack of effective harmonised planning and implementation of mitigation policies were seen as current tourism and conservation challenges, the minimal discussion of its resolution or its effect on support for tourism was conspicuous.

Addressing this prescribed theme in focus groups revealed support for tourism, despite HWC, through the acknowledgement that “even gorillas used to damage our trees, but they (tourists) benefit the country when they track gorilla” (N_M, M8). Employment opportunities were also acknowledged, as were infrastructural improvements;

"Some activities cannot benefit all the villages but when there are tourists, there are some people who work as porters for tourists. And we can say also guides and trackers. If there were no tourists all these people would be jobless.” (K_M, M4).

Discourse throughout referred to National benefit. However, investigation of benefits accrued locally through revenue sharing or employment revealed similar animosity to that expressed in preliminary findings;

"We don’t have people from our villages working as porters, guides or trackers. Even these roads, we are the one who are in charge of their upkeep” (K_M, All),

"We don’t share with the park the revenue generated, when the park is isolated” (N_M, M1),

"We need to protect the park, because it generates much money. But the main problem is that the government doesn’t share this revenue with us” (S_F, W2).

Quantification of this attitude to tourism and revenue sharing through survey transects revealed that only 1.6% (n = 3) of those sampled within 1km of the VNP boundary claimed to be a member of a cooperative receiving revenue sharing from either RDB or from another cooperative. These
were all found in the centrally-located Kinigi Sector. This result was corroborated by the opinion of an experienced conservation and development practitioner of the region;

"I think it would be very naive to think that the social viability of the park could be reliant on the revenue that the park generates. You know, with the population levels there I think it would be terribly naive" (G. Daconto, CARE International)

Of those not receiving revenue sharing, 17.8% (n = 32) did not know why, while 6.6% (n = 12) claimed it was because their cooperative was new. Others claimed that they may avail of this "in the future, as all of us cannot get it at the same time" (Shi15.4) or cynically that "maybe our president did not ask us or is shy" (Kin26.4).

When questioned over how future shared revenue could be utilised, the majority of responses concerned increased farming and livestock investment (fig. 6.23). Notable here was the low priority attributed to compensating HWC damages or investing in mitigation efforts.

![Figure 6.23: Accounts of potential uses of future revenue sharing payments, either through direct payment or through official cooperatives. N = 311.](image)

6.4.2.2 Perceptions of conservation and impacts of HWC on this

Preliminary accounts given by conservation organisations and government led tourism initiatives revealed that crop raiding by forest-based animals has significantly affected livelihoods and perceptions of conservation efforts. Interviews with VNP officials suggested that buffalo were the
most prominent of these species, citing recent human mortality events and damages to the Sabyinyo Silverback tourist lodge located near the VNP boundary. For employees of local conservation NGOs, conversely, gorilla crop raiding was thought to most impact conservation efforts;

"Everybody can be responsible for the park and conservation. But according to the crops damaged a long time ago without payment... there are many complaints from the people around the park" (DFGFI source)

This latter problem manifested through imposition of a minimum allowable distance from a gorilla or group of gorillas, meaning that farmers could not tend fields if gorillas were present (K. Fawcett, 2011, pers. comm. 11th January). Though this was not highlighted by any participants in village or cooperative meetings (in the presence of some or all of the Community Conservation Wardens, the VNP manager, local law enforcement and Sector Executive Secretaries), individual informal discussion with farmers and conservation NGO staff revealed that animosity towards gorilla conservation was strong as a result of these restrictions.

Thus, support for conservation, though expressed strongly at a public level, seemed imposed by external agencies. Throughout public meetings facilitated by the Community Conservation Wardens of VNP, aimed at solving crop raiding issues and human use of forest resources, rhetoric of cooperation and compliance was used. Limited public engagement or participation in this communication process was observed, however, with most interactions aimed at education and ‘sensitisation’.

Focus group transcripts revealed deeper animosity towards conservation efforts, particularly in terms of the expressed futility of buffalo mitigation measures;

“For me I cannot protect the park, because I cannot protect against buffalo” (S_F, W3)

“They (VNP representatives) come and register the damage and it’s finished. They don’t care about it” (J_F, W1)

In addition, socioeconomic arguments were made against the potential costs of conservation to local people;

“Do you think we can afford to protect these strong animals? We cannot afford to protect these animals” (R_F, W1),

“I and you all, we are also in need of good care. We have to conserve ourselves, and then conserve the nature” (N_M, M6).
This point reflects expectant imposition of fees upon park-adjacent communities to build and strengthen boundary defences, a point raised in several separate community meetings and in conversations with VNP management. Conversely, with increased sharing of park revenue, some claimed that community contributions to conservation may be more feasible in the future;

“If we can get enough support we can protect the park” (S_F, W5),

“I would put more guards in order to fight against poachers and briefly to avoid illegal use of the park.” (K_M, M6)

Conservation initiatives were also seen as job creators, which in the future may offset damages incurred through crop raiding. It was hoped that continued conservation would bring “many jobs to the local community to encourage them to protect the forest sensitively and this will be compensation for the damage caused by wildlife since years ago” (K_F, W6). However, it was noted that some of these remain voluntary positions, a point corroborated by VNP management;

“For us who are conservation sensitizers, they even don’t pay us. We work every day looking for poachers and when we arrest somebody using the park illegally, we call them (VNP management) and they punish the person. But in return, they don’t give us a salary or an incentive.” (N_M, M4)

Figure 6.24: Perceived actions of RDB to conserve VNP, as expressed through surveys along transects perpendicular to the forest edge. n = 164.
Further investigation of this prescribed theme through surveys revealed similar views. Of 180 survey respondents, 61% (n = 110) believed RDB conservation efforts were limited to employment of guards (fig. 6.24). Similar to focus groups, employment through conservation efforts were acknowledged, though damages to crops and the role of conservation in this was also highlighted:

"If they were able to keep animals in the forest there would be no more raiding." (Kin17.2)

Animosity towards conservation, though less apparent than focus groups or individual informal discussions, was strong when expressed, claiming that RDB "employ guards and community people to protect park, but does nothing to protect people" (Rug40.1) and that "it was the government who appointed RDB to protect the park, but I don't know why" (Rug40.4). In terms of local action to conserve, 27% (n= 49) claimed that they contribute nothing to VNP;

"What can we give to the park?" (Bug4.4)

However, when triangulated against a later question (D6: What do you do to protect the park?), 21% (n = 39) claimed they do nothing to conserve VNP, while 49% (n = 89) admitted to reporting illegal use of the forest to authorities.

Generally, satisfaction with RDB activities in park conservation and relationships with forest-adjacent people (measured through the binary response to the question “Are RDB doing enough to conserve the park and the people who live around it”) was low. Fifty six percent (n = 101) of respondents within 1km of the park boundary were dissatisfied with RDB activities, compared to 30% (n = 54) who were satisfied (14% (n = 25) had no opinion or was not expressed).

The effect of park proximity on the above response, tested through Pearson Chi-square, was not significant (13.747, p = 0.089), though an apparent increase in support for conservation efforts at mid-range distances from the park was observed (fig. 6.25).

However, binary logistic regression of attitude to conservation versus the number of expected raiding events, using the derived measure of 10-year recall, did not find a significant relationship between the number of raiding events and attitude to conservation (0.124, d.f. = 1, p = 0.724).
6.4.3 Emergent themes

The following themes became apparent throughout preliminary discussions and focus groups, and were investigated further at survey level, to better understand how human-wildlife conflict affects tourism and VNP conservation.

6.4.3.1 Ecological understanding

Information gathered through attendance at community meetings and through informal interviews with park-adjacent residents revealed a surprisingly comprehensive understanding of the ecological processes involved in HWC and the ecosystem services VNP provides. It was mentioned, for example, that slope allows animals to see over park boundaries and that water access for forest-dwelling animals may be as important a driver of presence outside VNP as food availability.

This theme emerged further in focus group transcripts through description of perceived ecological factors determining HWC. These included perceived resource shortages within VNP causing animals to exit (“Oh, buffaloes lack enough food resources in the park and that push them to come and get more to satisfy their food security”, B_F, W8), intrinsic carrying capacities being met within the forest (“There are so many (buffalo) in the forest. They have to reduce them”, K_M, M1) and the general preference of farmed crops over forest forage (“They like potatoes because they don’t find it in the forest” K_M, All). This latter point corresponds to the opinions of a regionally-experienced ecological researcher (A. Plumptre, pers. comm. 2011), who claimed that crop raiding...
may be explained by preference and not ecological necessity. Additionally, the seasonality of raiding events, in line with availability of forest forage such as young bamboo shoots, and the role of increasing human populations on the margins of VNP in determining an increase in HWC, were both noted across focus groups.

The ecosystem services provided by VNP, such as erosion prevention, regulation of rainfall and climate stabilisation, were all clearly stated;

"The preservation of the park is very important because the forest provides water, rainfall, and also if we don't have this forest erosion would be a very serious problem" (B_M, M1)

"We preserve the forest because the forest has many benefits. We get from it such as fresh air and also it protects us from erosion" (N_F, W6)

However, the ability of the forest to prevent the spread of infectious diseases such as malaria, by providing fresh air, was also claimed on several occasions;

"We are lucky because the forest ... brings about fresh air that makes us immune to many diseases" (B_M, M4),

"The park must be conserved because it ... gives us good air and protects us against malaria." (R_M, M5)
Limited quantification of this emergent theme was achieved through directed questioning during survey transects. Of those offering an opinion, perceived causes of animals ranging outside VNP were predominated by lack of within-forest forage and increasing populations of forest dwelling animals (fig. 6.26).

The value of VNP was similarly investigated through directed survey questioning, which showed that the majority of respondents understand the ecological and potential-financial benefits accruing from VNP (fig. 6.27).

![Figure 6.27: Perceived benefits of VNP to local people. Infrastructure includes water tanks, schools, roads and electricity. N = 257.](image)

Several survey statements point to frustration over increasing animal numbers as a result of tourism-driven conservation initiatives;

"There used to be hunters in forest, but now numbers are increasing because of the hunting ban." (Rug40.3)

In some cases, increasing buffalo numbers were regarded as an unfortunate consequence of tourism success;

"We think the government has benefit from tourism. But here tourists are visiting gorilla, not buffalo." (Kin32.1)

### 6.4.3.2 Responsibility for, and use of, the forest

Consultation with conservation NGOs and VNP management reported high levels of forest use, manifested through wood-cutting, water abstraction and the trapping of wild animals. DFGFI
ranger patrols reported destroying over 1,080 snares across the three national parks of the Virungas TBPA in 2010 (unpublished data, with permission of DFGFI). It was found that regulated water collection and wood cutting was permissible at defined periods annually, though abuses of this system were highlighted by VNP management and military commanders in community meetings (Kabatwa village meeting, 08/02/11).

“If you see, what we miss most is water. Really water shortage is a big problem for us during the dry seasons, even if they allow us to go in the forest to collect water.” (J_M, M6)

Of those surveyed, 38% (n = 68) admitted to using park resources, 93% (n = 63) of which was for water, though the legality of this was unknown. Given claims of imprisonment, heavy fines and land confiscation if caught illegally collecting VNP resources, honest disclosure was unlikely.

Seemingly as a means of lessening illegal use, early rhetoric from VNP management during public meetings centred on encouraging shared responsibility for the park through harmonisation, claiming that “the park is in all of our hands” (Kabatwa Sector office, 08/02/11).

Later statements from cooperative leaders relating to water collection echoed this, when it was claimed water collection within the forest is controlled well but that it “needs to be harmonised” (Kabatwa Village meeting, 08/02/11).

The encouragement of mutual responsibility and the cooperation of local residents did not correspond to substantial amounts of revenue sharing (highlighted in section 6.4.2.1 of this chapter), particularly in areas to the extreme west of the VNP boundary which benefit much less than central sectors (“Park conservation here is 100% shared as a responsibility”, Executive Secretary, Bugeshi Sector). This suggested that the promise of revenue sharing has been used as leverage to instil cooperation, as it was stated in one management meeting that contributing to cooperatives has garnered a greater feeling of shared responsibility than through the funding of infrastructural projects. The inclusion of buffalo wall construction and maintenance, without pay, as part of monthly Rwandan civic labour (umuganda) was similarly reinforced through encouragement of responsibility with the promise of eventual revenue sharing benefits. However, informal discussion with local residents did not reveal unanimous support for shared responsibility. Pressurised responsibility for conservation also emerged throughout male and female focus groups;

“When they (RDB) talk about conservation, we understand that we have to protect the park” (K_M, M1)
Furthermore, administered surveys revealed that the majority of residents (83%, n = 149) living within 1km of the park saw the RDB or VNP staff as being responsible for the park and its maintenance, whereas self-declared responsibility was half this figure (42%, n = 76) (fig. 6.28).

6.5 R04 – Ascertain the nature, extent and effectiveness of current mitigation and appraise potential future solutions

The extent and nature of strategies adopted to mitigate HWC on the margins of VNP are outlined in this section. In addition, the effectiveness of these methods is assessed while proposed future mitigation is investigated.

6.5.1 Summary

A combination of field observations, public meetings, focus groups and administered surveys revealed that prevention and mitigation of conflict is limited to a small set of methods. Physical barriers of highly varying quality are in place, the construction and maintenance of which is coordinated by VNP management. Other small-scale locally-implemented physical deterrents are also in use. Active guarding of crops is the most commonly-stated mitigation strategy, most of which is conducted by farmers themselves or by hired labour. The significant amount of time and money spent on this was seen as a necessary cost, while those who guard crops expect to lose significantly more in the coming year than those who do not. High intensities of buffalo and elephant crop raiding coincided with areas of good quality wall, though this taxa-specific response was not ubiquitous. In light of current mitigation shortcomings, proposed solutions included
increased VNP investment in physical barriers, monetary compensation for crop raiding losses, more open use of forest resources and the provision of alternative livelihoods.

6.5.2 Current mitigation

6.5.2.1 Active guarding

Preliminary discussion with park-adjacent farmers revealed that most guard crops at some time of the day, either personally, by instructing children to do so or by employing a person to guard crops. This was confirmed through personal observations of children chasing golden monkeys, farmers sleeping in guard huts at the edge of the forest and through focus groups and public meeting where guarding using fire, lamps and drums was presented as acceptable continued mitigation. There was suggestion, however that this may be the sole option in the absence of hunting;

“We chase buffaloes by making noise with empty jerry cans used as drums. But they escape and go to elsewhere” (N_M, M3),

“When wild animals come out of the forest, and enter our plots, we cannot kill it. We have to find a way to chase it and it can go back to the forest.” (K_M, M1)

VNP officials referred to guarding as an appropriate defence against porcupine and golden monkeys. Expanded responses to the survey question “Is anything done to stop this” revealed that, of those experiencing crop raiding, 83% (107/129) guard their crops. Additionally, a number of respondents not experiencing crop raiding admitted to guarding crops against thieves. Of those who guard crops against either forest-dwelling animals or thieves (n = 110), the majority (54%, n = 60) employ adults to guard crops (fig. 6.29). The low rate of child guarding (13.5%, n = 15) is also notable here.

Of those able to estimate the cost of employing either adults or children to guard crops (n = 76), an average of 12,206 RwF (S.D. = 21,614) was spent per month. The wide range of values for this (fig. 6.30) may be explained through variability in land holding, exposure to raiding and availability of labour, while the positive skew of the distribution (skewness = 4.302) is indicative of the limited number of large landholders adjacent to VNP.
Of those not employing guards, estimates of time spent guarding could not be accurately quantified. Most descriptive accounts of guarding methods involved the drumming of plastic jerry cans or the lighting or small fires. To counter daytime raiding by golden monkey it was claimed a farmer’s presence in the field suffices.

Guarding also involved the construction of small temporary guarding huts, at various locations in VNP-adjacent land (fig. 6.31). The concentration of these huts around more central regions of
park-adjacent land corresponds with higher rates of nocturnal raiding by forest fauna. This is in comparison to western regions where diurnal raiding by golden monkey predominates.

Figure 6.31: Map showing the location of purpose-built guarding huts on the margins of Volcanoes National Park, geolocated during the boundary survey.

**Limitations of guarding**

In certain regions of park-adjacent land, the combined activity of nocturnal and diurnal raiding species is a significant limitation to the effectiveness of active guarding, as it necessitates round-the-clock guarding. Additionally, personal observations indicated that golden monkey seem increasingly habituated to human presence in fields and in one observed instance did not react to stone-throwing or shouting by children less than 50 m away. The danger posed to human life by animals larger than golden monkey, such as buffalo and elephant, was also raised as a limitation to guarding;

"Nothing we can do, do you think we can fight with buffaloes? These are strong wildlife; we don't do anything." (R_F, W1)
The restrictions on what is permitted by authorities were also noted, with some claiming that “even if you throw a stone at a buffalo you are jailed.” (Rug.38.2)

6.5.2.2 Physical barriers

Drystone “buffalo” Wall
The predominant demarcation of VNP is a drystone wall, locally known as the “buffalo” wall (fig. 6.33 a). In addition to establishing a visible boundary, this wall was intended to mitigate crop raiding by forest fauna. From boundary survey data, wall quality varied significantly across the 65km of VNP boundary, from no discernible wall present in localised areas of western and eastern extremities, to double-thickness wall in more central areas (fig. 6.32). A significant portion of the boundary bordering the DRC was without any form of boundary, with farmland abruptly transitioning into the Mikeno Sector of Virungas National Park. Central regions displayed more established wall, some lengths of which were double-thickness following designation of this area as a critical zone of crop raiding around VNP, according to Community Conservation Wardens. Eastern regions of poor quality wall towards the Ugandan border were also observed.

Figure 6.32: Map showing the quality of wall and the presence of defensive trenches on the margins of VNP, assessed at 200 m intervals during the 4-day boundary survey.
From preliminary discussion with VNP management, attendance at public meetings and focus group transcripts, construction and maintenance of this wall seems exclusively achieved through the labour of local farmers and relies strongly on the encouragement of responsibility for conservation, discussed earlier in this chapter. One meeting participant, however, took exception to this by insisting that only those living directly adjacent to VNP should be responsible for wall maintenance (Community Conservation Teams Refresher Course, 20/09/11).

When asked during surveys to mention ways in which crop raiding was mitigated, 4.5% (n = 8) of respondents independently cited the stone wall, most of whom expressed discontent with its effectiveness;

"We reported to RDB to make a wall but the wall is not helping." (Kin29.2)

In regions displayed in Figure 6.32, this wall is combined with a 1 x 1 m trench on the forest side of the wall (fig. 6.33 b). Though often combined with more advanced drystone wall construction, the digging of trenches was also seen by some locals as a viable stand-alone solution to large mammalian raiders. VNP management additionally suggested that payments for digging trenches could originate from revenue sharing from VNP or could be included in umuganda civic labour obligations, similar to wall construction obligations. Meetings with VNP management and Military
commanders revealed a preference for doubling the dimensions of this to 2 x 2 m (Kabatwa Sector office meeting, 08/02/11).

Sections of single-strand barbed wire fence limited to central regions of VNP-adjacent land in Kinigi and Shingiro Sectors (fig. 6.33 c) were also seen enclosing individual plots. These appeared, however, to be for the exclosure of domestic livestock as they were unlikely to impede either small primates or other forest mammals considerably larger than domestic livestock.

**Limitations to barriers**

Though in local meetings people seemed willing to continue maintaining and improving defences, the acknowledgement that “the wall only stops buffalo and not golden monkey or porcupine” (Woman, Bugeshi village meeting, 13/09/11) was prevalent. This opinion was subsequently dismissed by VNP management as a ‘general issue’. Furthermore, it was felt that the wall was not strong enough to completely impede buffalo and elephant;

“...those small and easy penetrable walls are really nothing compared to the strength of buffaloes.” (K_F, W3)

Shortages in adequate building material were also expressed in some regions, particularly in Bugeshi Sector (Bugeshi Sector meeting, 13/09/11), an area where most dwellings are wood-built and a park boundary wall is currently absent. In addition, the cost of labour involved in trench digging was estimated by one community leader at between 4,000 and 4,500 RwF per cubic metre. The proposed doubling in dimensions of existing and new trenches (Kabatwa Sector office, 08/02/11) would also greatly increase labour requirements, from 1m³ to 4m³.

Survey respondents suggested that local residents may have previously maintained gaps in the wall to allow for access to water within the forest, thereby offsetting motivation to secure defences against animal exit through human necessity to enter VNP;

“We cannot fence or build wall because we also go in the forest to collect water.” (J_M, M7)

Finally, control over permission to maintain walls was raised at cooperative meetings, resulting in calls to allow people to repair walls without expressed authorisation from cooperatives or VNP management. In one example given, animal damage was repaired in one cell, though restrictions on umuganda civic labour programmes resulted in other nearby damage being omitted.

**6.5.2.3 Other mitigation**

Observations of bee hives resting on and near the boundary wall were made through the course of fieldwork. Though more likely an artefact of expressed lack of flowering plants outside VNP
(CCT meeting, 21/09/11), this strategy has been identified as an effective elephant deterrent elsewhere (King et al., 2007; Hoare, 2012).

The use of white plastic bags attached to vertical poles amongst farmland, acting as rudimentary scarecrows/fladry, was also recorded, though few of those asked adopted this strategy. Given that plastic bags have been outlawed in Rwanda, their use on a larger scale may be restricted.

Though the above use of deterrents and physical barriers was a dominant mitigation and prevention strategy, mechanisms to strengthen the financial resilience of affected farmers also existed. This was found to exist as locally-administered remittance schemes, whereby village-size groups contribute to a communal fund monthly, the full sum of which is distributed to members on a rotational basis (Benda, 2012). Remittances were not seen as centralised compensation for damages, but a coping mechanism giving farmers the finance to re-establish crops when damaged, while it was stressed that none of this originated from revenue sharing.

6.5.3 Effectiveness of current mitigation
A non-paired T-test revealed that those who guard crops expected to lose significantly more in the coming year than those not guarding (t (48) = 2.417, p = 0.019513). Overlaying the frequency of reported crop raiding events in 2012 with the quality of boundary defences (fig. 6.34) revealed a relationship between quality of defences and levels of raiding in areas where buffalo and elephant raiding predominates, around the central zone of the VNP boundary and in some areas to the east. Conversely, in areas to the west exhibiting comparably high frequencies of crop raiding, boundary defences were poor. Unusually, in areas to the east which experience little primate raiding, defences remain poor though raiding frequency was found to be high.

6.5.4 Future solutions
Perceptions of more effective solutions to future conflict were expressed across all methods, either through direct questioning or voluntary elaboration.

6.5.4.1 Physical barriers
The majority of perceived future solutions centred on strengthening existing physical barriers. This included the use of concrete in wall building and the extension and deepening of trenches, though the largest proportion of survey responses (39%, n = 70) admitted that future barriers would still be ineffective against the current suite of raiding species;

“We as people can't do anything. Only RDB can do something” (Nya37.1),

“If we could do something we would have done it.” (Nya35.4)
Trial wall reinforcement was proposed by VNP management in defined western sectors (Bugeshi Sector meeting, 13/09/11). Furthermore, it was suggested in focus groups that this could be collectively funded, though this likely originated from suggestions made by Community Conservation Wardens of VNP, as figures and formats of such a scheme corresponded closely;

"We will first put a very tough cement wall to protect us from buffaloes, even if each household gives a contribution of 1000 Rwf." (K_F, W1)

6.5.4.2 Active guarding

Increases in guarding were recommended by a much smaller proportion or residents and were seen as the only viable continued strategy by some survey respondents, though adequate equipping of these guards was stressed both in preliminary meetings and in focus groups;

"Three things are required to prevent conflict: big torches, raincoats and boots. That way, more guards can be employed to do this" (Military Commander, Bugeshi village meeting, 13/09/11)
“If we can get night torches to prevent them to come because buffaloes fear light during the night” (B_M, M3)

6.5.4.3 Compensation

Although previous studies have highlighted the limitations and counter-productive consequences of compensation schemes (Bulte and Rondeau, 2005; Gubbi, 2012; Barua et al., 2013), park-adjacent communities recounted that VNP management were in the process of establishing such a scheme to mitigate losses incurred through crop raiding. This was confirmed through discussion with park management, who claimed that case-by-case compensation has occurred in the past while organised government-funded compensation is being planned. Concurrently, however, VNP management claimed that “compensation is not sustainable” (Kabatwa Village meeting, 08/02/11), outlining that “compensation will not solve the problem, as VNP conservation must be owned by us all” (CCT meeting, 20/09/11). In this way, though it is claimed that RDB guidelines have been developed for compensation, management have underplayed its potential significance.

Survey respondents claimed that there has only been compensation “for those whose house was destroyed by elephant” (Kin22.5), while appeals relating to crop damages have been ignored;

“We used to report to RDB, who keep promising to compensate but this hasn’t happened.” (Kin26.4)

Similarly, few (4%, n = 7) respondents offered compensation as a viable solution, under the understanding that “compensation does not come” (Nya37.1). Corresponding doubt surrounding the viability of compensation was expressed by a leading development worker in the region (G. Daconto, CARE International, 09/02/11).

6.5.4.4 Regulated use

Separate from continuing regulated access to water and firewood at defined periods, several park-adjacent farmers called for the re-establishment of within-forest hunting rights as a mechanism of reducing animal numbers and thus mitigating conflict;

“The government tell us we can’t touch animals. If we had permission we would kill animals so they wouldn’t come out.” (Bug6.4)

This was contradicted by others who claimed that, though “government animals are only for the government” (Nya37.3), park fauna generates revenue for local communities.

Community Conservation Wardens of VNP did, however, concede that “some sites can have regulated poaching areas, perhaps to reduce numbers” (CCT meeting, 20/09/11).
6.5.4.5 Improved or alternative livelihoods
A final posited mitigation method was the improvement of alternative livelihood options, under the assumption that this would lessen the burden of HWC;

"After putting the fence and seeing that animals are no more damaging the crops in the field, I can fund these people by helping them have some projects." (K_M, M1)

6.6 R05 – Assess the potential of an insurance scheme to mitigate losses due to conflict
This section details the results of a feasibility study into the introduction of a locally-run insurance scheme to mitigate losses incurred through crop raiding. This includes a qualitative account of similar existing mechanisms in the region, the results of a CV exercise attempting to measure local value of such a scheme and a quantitative assessment of factors dictating its acceptability.

6.6.1 Summary
The operation of existing national insurance schemes and local savings collectives indicated that the implementation of a locally-run insurance scheme against crop damages, similar to those in operation in other HWC examples, may be acceptable. A CV exercise did not reveal adequate response patterns for subsequent premium calculation and was abandoned. Post hoc validation of this, however, revealed that an insurance scheme would reduce perceived expenditure on other mitigation, while mandatory payment into an insurance scheme was preferred to payments aimed at strengthening defences. A multivariate model predicting participation did not yield good predictive power, using the data collected in this study.

6.6.2 Justification of potential: overview of extant common funds
Though Mutuelle de Santé health insurance operates in Rwanda, this is run at a national level and participation has been mandatory. Voluntary private property insurance also exists, though this was not referred to by respondents at any stage of research. It was unlikely that the income of the majority of park-adjacent residents would allow for such insurance.

A scheme similar to the proposed HWC mitigation insurance, involving local contributions to fund a common good, was recounted by local farmers;

"It's the electricity... we formed a cooperative where we were depositing money monthly to bring electricity in our village. But finally the money came back to us and the cooperative manager said it will not work possibly, to avail all required materials to bring
electricity. They gave our money back to us after a period of a year of giving contributions every month.” (R_F, W3)

The inclusion of a minimum fund size here (to allow the purchase of materials) and the concept of proportional rebate upon its eventual non-use, highlighted important similarities between it and the proposed insurance fund mechanism. Furthermore, its establishment under a cooperative template may have facilitated VNP revenue sharing contributions.

Analogous funds were independently proposed by focus group respondents to raise money for buffalo wall construction, whereby they would “first put a very tough cement wall to protect (them) from buffaloes, even if each household gives a contribution of 1000 RwF” (K_F, W1).

Further to this, preliminary investigations revealed that small-scale rotational shared funds, or remittance schemes, were in operation (Verpoorten, 2009) while several survey participants claimed that these existed specifically to lessen the socioeconomic impact of crop raiding. It was stressed by respondents that this was not funded by the Rwandan government or through VNP revenue sharing contributions. Recent investigation of these small-scale rotational savings schemes in the region uncovered their long-term existence and importance in stabilising livelihoods when operated at small scales (Benda, 2012); a role micro-insurance schemes may play in this case to buffer against socioeconomic loss as a direct result of HWC

6.6.3 Contingent valuation

Of those survey respondents presented with the CV scenario (n = 177), participation was high (98%, n = 173), with the remainder (n = 4) protesting based on failure to accept the scenario. Initially-offered DC values, randomly selected from a range defined by reasonable local monthly expenditure, yielded the distribution found in Figure 6.35. The low frequency of 1,000 RwF offers can only be explained by chance, as selection of values was as random as possible.

Responses to the first DC value offered did not exhibit an expected pattern of reduced acceptance with increasing price (fig. 6.36). Acceptance rates were high for all theoretical contribution values offered.
The data were then split using the potentially-explanatory discrete classes of gender, socioeconomic class (derived and government-imposed) and distance to the VNP boundary. Both derived and government-imposed socioeconomic categories were split between the first and second-to-third categories, to obtain roughly equal representation, while distance to VNP was split based and greater and less than 500 m, given the distribution of damage events found in previous sections of this chapter.
Figure 6.37: Scatterplots, depicting data on proportional acceptance (y axes) of offered prices (x axes) based on the discrete data splits of (a) gender, (b) socioeconomic categories derived earlier in this study, (c) government-imposed socioeconomic categories and (d) distance to VNP.

Discrete class splits for gender (fig. 6.37 a), derived socioeconomic category (fig. 6.37 b) and distance to VNP (fig. 6.37 d) did not exhibit discernible responses to increasing offer price. The split based on the poorest government-imposed socioeconomic category (fig. 6.37 c) showed weak correlation between offer amount and proportional acceptance ($R^2 = 0.5137$). Without the expected behaviour of decreased participation with increasing theoretical price, either in aggregate data or discretely-split data, no further analysis could be carried out to estimate local value of such a fund or to develop an insurance premium function.

Under an assumption that participants may have used the first DC question to learn about the scenario, analyses of the second DC question results revealed an interesting, though counterintuitive, pattern. These data included DC offers of the original range plus and minus 300 RwF, regardless of acceptance or rejection of the first offer. Exclusion of two potential outliers in this relationship, at 300 and 1,300 RwF bid values, yielded a strong positive relationship ($R^2 = 0.8732$) between increasing cost of insurance scheme and willingness to participate (fig. 6.38).
6.6.4 Willingness to participate

6.6.4.1 Support for insurance scheme

When asked whether they would still spend the same amount of time or money protecting crops, the majority of respondents (89%, n = 111/124) claimed that insurance would allow a reduction of time or money spent guarding crops. Additionally, when given the scenario of mandatory payment into either an insurance scheme or as a contribution to strengthening boundary defences, the majority (55%, n = 83/150) chose insurance, with some claiming that "the wall cannot ever be strong enough to stop raiding" (Kin32.1) and that "it is up to the government the build their wall" (Kin29.2).

In a number of cases, respondents expressed willingness to participate in an insurance scheme despite experiencing no crop raiding. Many of these felt obliged to help others or acknowledged that raiding may not be a current reality but is conceivable in the future;

"While giving Mutuelle (de Santé) it doesn't mean that you will be sick. It's to help. Giving this I will be helping others" (Bug3.1),

"Insurance doesn't mean that you have a problem now." (Jen10.2)
6.6.4.2 Factors dictating participation

In order to test which variables dictate acceptance of DC values, construction of a binary logistic model of participation was conducted, based on responses to the second DC valuation question. Given that the large majority of those surveyed experience crop raiding (72%, n = 129), it was not possible to test the effect of crop raiding on levels of participation. Additionally, as the first DC offer was not found to be related to participation in the scheme, the second DC offer was used in its place, as a strong relationship was observed between these values and percentage acceptance. It could not be assumed, however, that the outliers of this relationship would behave similarly in other model relationships which were therefore not excluded from the logit model. Results of this binary logistic regression are shown in Table 6.9.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Expected Sign of Correlation</th>
<th>Significance levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership of land (Own = 1)</td>
<td>+</td>
<td>0.999</td>
</tr>
<tr>
<td>Control of crops (Yes = 1)</td>
<td>+</td>
<td>0.197</td>
</tr>
<tr>
<td>Age (scalar)</td>
<td>-</td>
<td>0.468</td>
</tr>
<tr>
<td>Gender (Male = 1)</td>
<td>?</td>
<td>0.923</td>
</tr>
<tr>
<td>Derived socioeconomic status (categories 1-4)</td>
<td>+</td>
<td>0.367</td>
</tr>
<tr>
<td>Household size (scalar)</td>
<td></td>
<td>0.223</td>
</tr>
<tr>
<td>Distance to VNP boundary (categorical: 1-5)</td>
<td>-</td>
<td>0.976</td>
</tr>
<tr>
<td>Plot size (scalar)</td>
<td>+</td>
<td>0.486</td>
</tr>
<tr>
<td>Second dichotomous choice offer value (scalar)</td>
<td>+</td>
<td>0.000</td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>170</td>
</tr>
<tr>
<td>Model coefficient $\chi^2$ and significance</td>
<td></td>
<td>43.018 (0.000)</td>
</tr>
<tr>
<td>-2 Log Likelihood Ratio</td>
<td></td>
<td>162.953</td>
</tr>
<tr>
<td>Percent correctly predicted</td>
<td></td>
<td>78.8</td>
</tr>
<tr>
<td>Hosmer Lemeshow Test significance</td>
<td></td>
<td>0.852</td>
</tr>
<tr>
<td>Nagelkerke pseudo-$R^2$</td>
<td></td>
<td>.318</td>
</tr>
</tbody>
</table>

The model was found to be well specified, with a significant model coefficient ($\chi^2 = 43.018$, d.f. = 9, p < 0.05) and 79% accurate estimation of results. Though the likelihood ratio (162.9) and Hosmer Lemeshow test (0.852) further indicated strong fit of the model to observed data, this is most likely explained through the disproportionate influence of the second DC value and its close relationship with proportional acceptance, as individual variables inserted into the model were
not found to be significant. The Nagelkerke’s $R^2$ of this model, at 0.32, shows this overall lack of fit. This shows that participation in a proposed insurance scheme cannot be predicted using the data collected in this study, apart from the 2nd DC offer used in CV, though this was counterintuitive in relation to increasing value.
7. Results Synthesis

7.1 Overview
Using the results of each method outlined in Chapter 6 of this thesis, the following chapter synthesises these findings (described in Chapter 5) to address the research aim of this study through specific referral to the objectives devised to achieve this. It further assesses the effectiveness of each combination of methods in answering these five specific research objectives and explores the consequences and implications of these overall results toward the mitigation of HWC around VNP.

7.2 RO1 – Determine the form, level and range of human-wildlife conflict experienced by farmers adjacent to VNP
The combination of triangulation between varying qualitative methods and subsequent quantification used to address this research objective has allowed effective description of the form, level and range of human-wildlife conflict in communities bordering VNP. Crop raiding was found to be a substantial problem affecting park-adjacent farmers, as revealed by focus group and administered survey data. HWC was, however, one of several significant problems affecting residents living adjacent to the park, including shortages of agricultural consumables and land control issues. Conflict with the fauna of VNP was limited to agricultural disturbances, manifesting as crop raiding and minor damages to agricultural infrastructure.

Monitoring data confirmed that crop raiding remains a widespread issue, affecting most regions within 1km of the VNP boundary with some regions experiencing considerably higher raiding frequencies than others. These clusters of high frequency raiding were dispersed evenly across the park boundary. This pattern matches those predicted through a priori modelling of crop raiding around VNP. During interviews with local farmers, buffalo was the species most frequently implicated, while mountain gorillas – the species of most conservation concern – were largely dismissed as insignificant raiders. Though contrary to earlier reports, this was confirmed through monitoring data obtained in this study. Unique spatial distributions of raiding were observed for each species implicated, a finding which corroborates claims made in focus groups and surveys. No species uniformly affected land along the entire boundary of VNP.

Combining crop raiding perceptions obtained through focus group participatory methods with crop raiding intensities recorded through monitoring revealed a discernible 1-month lag (fig. 7.1).
Marked increases or decreases in actual raiding intensities are not reflected in perceptions of crop raiding until the following month.

![Graph showing perceived levels of crop raiding intensity compared to observed crop raiding intensities.](image)

**Figure 7.1:** Plot of perceived levels of crop raiding intensity, as derived in focus groups, compared to observed crop raiding intensities of 2012, as measured through monitoring.

Potatoes, pyrethrum flowers and wood-stock were the most affected crops along the VNP edge. Buffalo damaged potatoes and pyrethrum significantly more than other species did, while wood-stock (predominantly in the form of eucalyptus plantations) were disproportionately affected by mountain gorilla. The majority of crop damage was perpetrated at night, owing to the significance of buffalo raiding which was predominantly nocturnal. Though seasonal variations in raiding patterns were observed through monitoring data, these did not correlate strongly with seasonal rainfall patterns.

A wide range of costs were associated with HWC, beyond direct monetary loss. Costs included limitations to local development through farming restrictions, such as the opportunity costs associated with guarding crops and reduced dietary diversity through necessary crop modification. This latter set of development costs were expressed both in focus groups and surveys, and were predominantly felt by those farming land adjacent to the centre of the VNP boundary. Additional cultural conflict was identified as a result of HWC, between members of the batwa and sedentary farming communities. Accurate estimation of monetary loss through monitoring data was not possible as it required more thorough damage assessment than was feasible in this study.
7.3 RO2 – Establish the likely determinants of conflict, including spatiotemporal variation

7.3.1 Demographics

Perceptions of monthly crop raiding levels differed significantly with gender, with female focus group participants significantly underestimating exposure. Derived socioeconomic class had no relationship with perceived exposure to raiding through binary logistic modelling, though age of survey respondents and its collinear variable relating to the number years a respondent had been resident in the area were modelled close to significant.

![Figure 7.2: Comparison of planting proportions of key crops, derived from focus group accounts, with levels of proportional reported crop raiding damage for 2012.](image)

7.3.2 Land-use and tenure

The type of crop grown was described as affecting exposure to raiding, resulting in the cessation in cultivation of some staples. A combination of focus group data on planting proportions and monitoring data showing proportions of crops damaged revealed that potatoes, wood-stock and pyrethrum are disproportionately damaged (fig. 7.2). Peas, beans and maize are proportionally less damaged. Logistic regression showed that the mixing of crops does not significantly change perceived exposure to raiding. A shortage of arable land was also cited as exacerbating the livelihood impacts of HWC. Consequently, ownership of this land was found to significantly dictate the perceived exposure to raiding of those surveyed. Land-use consolidation and the intervention
of agro-industry interests are seen to further reduce resilience to HWC loss. Loss of agricultural autonomy to local or national government was directly related to heightened levels of perceived conflict, while the cultivation of pyrethrum was similarly related to increases in perceived exposure to the effects of HWC through reduced use of traditional robust intercropping systems.

7.3.3 Environment
Proximity to the boundary of VNP was found to dictate the suite of species implicated and the levels of perceived and observed raiding over 12 months. Slope and altitude of park-adjacent land were not found to affect levels of crop raiding, despite local accounts and a priori modelling suggesting otherwise. Local understanding of within-forest push factors affecting crop raiding risk and intensity was broad. It was understood that determinants of raiding may include shortages of forest-based forage or inherent preferences for nutritionally-rich arable crops. Testing of this local knowledge was beyond the scope of this study and is a likely source of poor ordinary least square model specificity, based on monitoring data, to identify determinants and their relative contributions to HWC intensity.

A combined figure exploring the likely determinants of seasonality and cropping trends did not reveal clear relationships with levels of crop raiding around VNP (fig. 7.3). Disregarding the high raiding value registered for the month of March, however, shows an inverse relationship with all other months. Though higher rainfall seems to be associated with reduced crop raiding, direct causation cannot be implied here.

Figure 7.3: Graph showing the combined results of focus group planting investigations, overlaid with line plots of rainfall data for northern Rwanda, and observed crop raiding incidences per month obtained through monitoring.
7.3.4 Consequences and implications

Valuable information on perceived exposure to raiding was collected, allowing the identification of significant determinants. Additional data on factors influencing the foraging behaviour of forest animals are required, however, to enable construction of a predictive spatial model of crop raiding: these additional data include within-forest push-factors, such as availability of forage in the National Park. Thus, this combination of methods has identified key likely determinants of HWC, though the remaining variance in monitoring data (and the spatial variation in significance of these determinants) remains unidentified.

7.4 RO3 – Determine the impacts of HWC on VNP tourism and conservation

7.4.1 Impacts on tourism

Attitudes to continued tourism in VNP, and the increasingly restricted use of forest resources, were ubiquitously positive throughout initial investigations of park-adjacent communities, mainly through acknowledgement of financial benefit to the Government. This is in spite of limited sharing of tourism benefits locally, such as employment, direct financial gain and infrastructural investment. Direct sharing of tourism revenue does occur, but only accounts for a small proportion of total revenue and is centred on a cooperative system that respondents and independent observers view as flawed. Community support for revenue sharing initiatives is thus low, as few of those exposed to potential crop raiding losses (within 1 km of the VNP boundary) receive these benefits. Tourism employment was also seen to be concentrated in specific park-adjacent regions and generally to involve non-locals. Consequently, though support for tourism and the associated restrictions on forest use seem high, HWC reduces this by perturbing livelihoods without adequate reciprocal benefit in the form of equitable revenue sharing. Though the majority of current revenue investment is centred on agriculture and infrastructure, few of those affected requested that compensation for HWC crop losses should be provided by this revenue.

7.4.2 Impacts on conservation

Support for the conservation policies linked to VNP was limited, with most regarding the efforts of RDB as inadequate to both conserve species within the park and to protect park-adjacent communities. It was felt by those farming park-adjacent land that these protection efforts were limited to the employment of guards and construction of boundary defences. Although not a significant relationship, those residents surveyed who farmed land closer to the VNP boundary...
expressed greater support for RDB conservation efforts than those farming further away. Furthermore, the magnitude of raiding as recalled during the last 10 years by park-adjacent farmers did not significantly affect attitudes to conservation measures. Throughout the study, strong feelings of responsibility for forest protection were expressed, using a discourse which expressed an obligation towards collective responsibility. This feeling of community responsibility was thought, however, to be instilled by local leaders. Conversely, the value of ecosystem services provided by VNP was widely understood and included water regulation, air quality and erosion prevention. Use of the forest is restricted by law to water collection during the dry season, with hunting and other resource extraction banned and strictly enforced. Increasing numbers of within-forest fauna – in part a consequence of reduced poaching – is locally thought to drive HWC.

7.4.3 Consequences and implications
Support for tourism and conservation of VNP continues to be affected by HWC, through differing drivers. Crop raiding reduces support for tourism by impacting livelihoods without adequate recompense in the form of equally shared revenue. Additionally, support for conservation is lost through restrictions on traditional HWC coping mechanisms (such as retribution killings of troublesome animals or chasing endangered fauna from fields) and resource extraction. Consequently, HWC will continue to limit support for conservation and tourism.

7.5 RO4 – Ascertain the nature, extent and effectiveness of current mitigation and appraise potential future solutions

7.5.1 Current prevention and mitigation
Personal observations, discussion with park-adjacent farmers and a comprehensive boundary survey revealed that prevention and mitigation of crop raiding around VNP was limited to a small set of strategies.

Active guarding was the most commonly adopted strategy for mitigating damage by those experiencing crop raiding by forest-dwelling animals. Most guarding was found to be carried out by hired guards or by farmers themselves. Guarding by children was found to be minimal and was restricted to daylight hours, generally after or before school. The time and money spent on guarding crops, though significant in some cases, was seen as a necessity. The limitations of this strategy are well-recognised, however, especially when guarding against habituated primates and large dangerous animals. Moreover, threatening endangered animals that might be damaging crops is illegal and punishable by imprisonment.
The construction and maintenance of a drystone wall (the 'buffalo wall') along the VNP boundary serves as additional defence, while prominently demarcating the extent of National Park territory. The quality of the wall, and thus its effectiveness as a barrier, was found to vary considerably, from a double-thickness wall combined with a trench in some parts, to its complete absence in others. Construction and maintenance of the wall and trench have resulted in substantial conflict between regional land owners and VNP management. Though the wall represents the result of significant investment and voluntary labour, many view it as ineffective, particularly against primate raiders. There was also the suggestion that barriers impede continued extraction of forest resources. Areas of substantial well-maintained wall coincided with areas of heaviest buffalo and elephant raiding intensities, suggesting that either defences are ineffective or that raiding could be even more of a problem in the absence of defences.

7.5.2 Future solutions
Perceptions of feasible future prevention and mitigation included increased investment in barriers, direct monetary compensation, more open use of forest resources and the provision of alternatives to forest resources and to existing livelihoods. In addition, extension of existing measures to other heavily impacted regions of VNP-adjacent land was requested by those affected, though resource shortages may limit this. Though a means of directly compensating farmers for losses is being established around VNP, verification of damages remains difficult, while the future equity of compensation schemes was doubted by those affected by HWC.

7.5.3 Consequences and implications
A combination of focus groups, survey transects, monitoring over the course of one year and a boundary survey investigation has effectively revealed the nature and extent of prevention and mitigation measures in place against HWC. This has also revealed shortcomings in specific regions of park-adjacent land where raiding by certain species could be reduced with the extension of existing mitigation.

7.6 RO5 - Assess the potential of an insurance scheme to mitigate losses due to conflict
Accounts of pre-existing local collective savings schemes and the operation of national health insurance suggest that the concept of local insurance for crop damages may be accepted. Also, independent proposition of mutual funds to finance other mitigation efforts (such as wall strengthening and livelihood development) indicate that the concept has already been considered by those affected. Though valuation exercises aimed at building insurance premium estimation
models were not trustworthy, unusually strong bid pattern relationships suggested that an insurance fund may be treated as a luxury good.

Willingness to participate in the scheme was high, with affected residents preferring to contribute to such a fund over investment in other forms of prevention and mitigation. When given an option, most would not continue to guard or build walls if paying into insurance. Though multivariate modelling of willingness to participate in an insurance scheme could not be adequately specified according to data obtained in the current research, theoretical acceptance of the scheme was widespread. Notable from this was the willingness of those unaffected by HWC to contribute, for the apparent benefit of the community as a whole.

Though a CV exercise was not useful in quantifying WTP into an insurance scheme, this procedure does indicate a strong willingness to participate regardless of exposure. Thus the findings of this research objective shows the potential for further development of a locally run insurance scheme as an alternative to other costly HWC mitigation efforts.

7.7 The constraints of HWC on conservation and development

This study aimed to describe in details the extent to which HWC constrains both conservation and development around protected areas, using the case study of VNP. The findings of the current study, synthesized above to address each research objective, have given the following answer to this research question.

This study has shown that the extent of HWC around protected areas can be extensive and can have significant costs to economically-marginalised farmers living close to protected areas. These costs include the financial burden of lost productivity, the opportunity costs associated with guarding crops and the investment of time and money in building barriers to prevent crop losses. In addition, cultural division was shown to emerge from HWC.

The current study has also shown that levels of HWC vary with both space and time, though socioeconomic drivers of this conflict, such as wealth status or land holding size, were not shown to dictate the incidence of conflict. Conversely, wider (distal) decisions taken at national, regional and international levels seem more important than local (proximal) factors in dictating levels of perceived and actual exposure to HWC. These include control of land and agricultural systems dictated by government desires to increase agricultural exports and the involvement of coercive international agro-industry. Similarly, perceptions of this conflict were not defined by case-specific factors, such as ecological or demographic conditions, but rather by the decisions of
national government, the conservation of the protected area driving this conflict and the tourism industry this supports, with HWC seen as a consequence of improved conservation, associated restrictions on forest use and higher controls of agricultural systems. Furthermore, inadequate sharing of revenue generated through nature-based tourism fails to compensate park-adjacent residents for sacrificing the use of protected resources and for tolerating losses due to HWC.

However, despite the set of livelihood impacts stemming from HWC, this study has also shown that perceptions of farmers towards HWC place this conflict amongst a myriad of development challenges already faced by marginalised communities, some of which are exacerbated by HWC. Additionally, the mitigation of this conflict is limited by conservation restrictions and the poor investment in strengthening boundary defences or providing alternative livelihoods.

Thus, from the above results synthesis, three important points emerge in response to the original research question of this study. First, HWC has a significant impact on conservation and development, through reduced support for conservation and restricting development of park-adjacent communities by diverting constrained resources towards crop protection in various forms. Second, levels of HWC and its impacts are not predominantly determined by local factors, but have broader political and economic drivers. Finally, though identified as a constraint on conservation and development, HWC represents one of several complex limitations to the development of marginalised communities and the conservation of valued biodiversity.
8. Discussion

8.1. Overview

The mixed methods approach used in this study has enabled HWC on the margins of VNP to be examined through the lens of political ecology. The form, level and range of this conflict have been described, including the varying effects of HWC on communities, conservation efforts and the tourism industry. Further, several factors determining the extent and magnitude of this conflict have been identified, through both qualitative investigation and quantification. The responses to HWC have been investigated, as have future proposed solutions. Finally, the feasibility of an insurance scheme against losses incurred through crop raiding has been tested.

This chapter explores the implication of each finding, relates this to previously-studied cases and places them 1) in the context of the aims and practices of conservation within VNP and the development of communities farming park-adjacent land and then 2) in relation to responses to HWC more broadly. This chapter also explores the limitations of the methods used to ascertain these findings and outlines future potential research around the Virungas TBPA in general.

Importantly, this study represents a case study of HWC around protected areas in resource limited regions of the developing world and its effect on conservation and development, and has shown the benefit of approaching this from a political ecology perspective. Thus, this chapter finally shows that the high human population pressure, complex resource politics and myriad stakeholders involved in VNP conservation and the conflict along its margins may forecast emergent conflicts elsewhere, as HWC becomes a greater constraint on development and conservation.

8.2 The nature and magnitude of HWC

This study uncovered significant levels of HWC on the margins on VNP, predominantly in the form of damage to arable crops. Furthermore, variation in the levels and nature of this conflict was highly apparent, including culprit species, crops affected and location in relation to the VNP boundary. The implications of these findings for VNP conflict mitigation and for global HWC generally are discussed in the following section.
8.2.1 Implications of this study for conflict around VNP

Results presented here identify crop raiding as one among several challenges to farming park-adjacent land. The political ecology of HWC around VNP, dictated by its high human population density, appears to have resulted in greater priority being placed on more immediate agricultural concerns, such as acquiring enough fertile land to grow sufficient crops in the first place. Human population densities close to the margins of VNP are generally high for a rural area in Rwanda (Bush et al., 2010). Even so, populations of forest taxa that are potential crop raiders may in some cases be close to or even have surpassed local carrying capacity (Owiunji et al., 2005; Robbins et al., 2011).

Comparison of perceived and observed seasonal trends in crop raiding revealed a 1-month lag in between the two. This may reflect the time taken to experience consequential financial loss and thus affect perception. Alternatively, the lag may have an unknown cause and reinforces the importance of understanding the perceptions of conflict specifically (Siex and Struhsaker, 1999) and attitudes to wildlife generally (Manfredo and Dayer, 2004), and the need for further study.

Though seven of the 86 mammal species recorded in the Virungas TBPA were implicated in crop raiding on the forest margins, this suite of species differs markedly from survey investigations of 1996 (Plumptre, 2002), which found hyrax, jackal and cane rat as troublesome fauna. Claims of extensive crop losses attributed to mountain gorilla were not verified in this study, being limited to damage to trees and bamboo. Though quantified in monitoring data, and claimed in qualitative focus group and survey methods, gorilla raiding was much less significant than raiding by several other species. One could assume that their size, daylight activity and affiliation with a lucrative tourism market would allow easier allocation of blame for crop damages (Tweheyo et al., 2005), though this was not the case. This may be based on awareness of their tourism importance and an associated reluctance to report damage events, as documented in Uganda with elephant crop raiding (Kamisse and Turkalo, 2002). In this way, gorillas seem to be perceived by farmers as an intrusion by the tourism industry into agricultural life, rather than a crop raiding cost, despite numerous accounts of disturbances to livelihoods associated with the ranging of gorillas outside VNP. The status of gorillas as a valuable flagship species for conservation and tourism ensures their continued protection by government and respect by affected farmers, meaning that mountain gorilla crop damage is likely to remain underreported. Furthermore, the often-coercive nature of tourism and conservation, discussed later in this chapter, may be a driver of this underreporting.

Compared with historical accounts around VNP (Plumptre, 2002), the extent of elephant crop raiding in this study was notable, and indicates its re-emergence as a source of HWC. Given that
an overall increase in population within the park and adjacent conservation areas in Uganda and the DRC has not been observed in more recent investigations (Owiunji et al., 2005) and is perhaps unlikely under contemporary poaching pressures in other parts of the region (Blanc et al., 2007), this increase in elephant presence in land bordering VNP may be explained by heightened instability on the DRC side of the Virungas TBPA causing within-park migration and a concentration of animals in better-protected parts, such as VNP.

In addition to low frequency high impact events such as elephant raiding, the frequency of low damage events perpetrated by small mammals was significant, as in other studies (Nchanji, 2002). The skewed representation of damage events to the category less than 50m$^2$ is indicative of the numerous raiding forays by smaller mammalian raiders and trampling damage, as opposed to extensive yet relatively infrequent targeted foraging events by groups of larger animals. It may also indicate the predominance of small holdings in VNP-adjacent areas. Whether this damage remains inconsequential or whether it represents a cumulative and constant cost to farming is unclear, however. Results suggest that damage by small animals is seen as an environmental condition beyond prevention or mitigation, such as invertebrate and avian raiding experienced elsewhere (Kagoro-Rugunda, 2004; Pérez and Pacheco, 2006). Similarly, though not reported in the raiding of standing crops in this study, rodents and invertebrates most likely affect stored food and therefore still impact livelihoods (Naughton-Treves, 1997).

The diurnal variation of raiding by implicated species corresponds closely to recorded feeding times for all species (Stuart and Stuart, 2006), with two exceptions. First, though elephants can be active at night depending on food availability and habitat, the dominance of nocturnal raiding in the feeding ecology of elephants from VNP may be the result of an unknown ecological pressure within the forest forcing this change or intelligent avoidance of human encounter, as postulated by Hoare (1999) previously. Second, the disproportionately nocturnal activity of black-fronted duikers on the margins of VNP may be explained by the recorded ability of antelope species to adapt diurnal feeding behaviour to ecological pressures such as human disturbance, hunting pressures and forage availability (Stuart and Stuart, 2006).

Data on proportions of tillage surrounding VNP do not exist but would likely confirm observations on the dominance of potatoes and pyrethrum as crops grown. It is unsurprising, therefore, that these are principally damaged. The inclusion of trampling inflates this by including non-foraged crops, even though raiding fauna may seek more desirable forage (Kagoro-Rugunda, 2004). The current study further found that planting proportions did not necessarily dictate raiding proportions. The heightened proportion of wood-stock damage can be explained by the crops longevity and resilience, allowing repeated raiding of single plantations. Furthermore, the low reported damage of peas, beans and maize could be a result of these being grown in gardens
closer to habitations, as personally observed, or could indicate the lesser preferences of raiding species. Other studies of primate and ungulate raiding, however, indicate a greater preference for these crops by mountain gorillas and buffalo (Biryahwaho, 2002; Hockings and Humle, 2009).

Though this study documents a wide range of claimed socioeconomic losses as a result of crop raiding, stated impacts may not equate to realised socioeconomic loss. For example, the larger claimed losses may be exaggerated under expectation of compensation, as noted in similar studies (Naughton-Treves, 1997; Gillingham and Lee, 2003). Furthermore, quantification of monetary loss as a result of specific taxa raiding certain crops in this study remains problematic. For example, animals feeding on eucalyptus trees, though extensively reported, may not result in tree loss as personal observations showed that, though bark had been removed by gorillas and porcupines, some trees still grew to profitable sizes. Although this may have compromised the quality of lumber, most eucalyptus is converted to charcoal or is used as rough poles for house building. Therefore, the financial loss resulting from sapling damage is likely limited. However, given that tree plantations may represent a form of ‘natural savings’ scheme for future generations (Hudson and Lietaer, 2006), damage to trees has wider social implications. Similarly, duiker and buffalo may feed on the leaves of potato plants (excluding trampling and buffalo digging for tubers), yet the loss of sellable productivity as a result is extremely hard to quantify and is thought in other cases to be limited (Hill, 2000). Quantification of monetary loss may be obtained using estimates of plant growth stage, area damaged, annual yield estimates of these and wholesale values of harvested crops, though these data were not available at the time of this study. Furthermore, although quantification of monetary loss through property damage is difficult, this was not reported by farmers as a significant problem around VNP and was solely perpetrated by elephants. Consideration of elephant conservation and conflict in sub-Saharan Africa, however (Hoare, 2012; Mackenzie and Ahabyona, 2012), and their increasing presence in land adjacent to VNP, means that damage to infrastructure may become a significant issue in future.

The opportunity costs of HWC are often-neglected, particularly in the developing world. These opportunity costs were an important finding of the current study. Notably, the substantial periods spent guarding crops at night in this case study are likely to increase exposure to infectious diseases, such as malaria during night guarding and diseases associated with extended periods of bare foot work such as podoconiosis (Korevaar and Visser, 2012). Additionally, other case studies uncovered substantial impacts on child school attendance (Kagoro-Rugunda, 2004; Mackenzie and Ahabyona, 2012). However, the division of school days into two sessions and the particular suite of dangerous raiding species in this case (against which children are not sent to guard) reduced the impact on school attendance around VNP.
A reduction in dietary diversity was, through a combination of obligatory land-use consolidation, crop raiding risk necessitating modification of crops grown and direct raiding losses, uncovered in this study as an additional opportunity cost. Indeed, other case studies have found similar impacts on local livelihoods (Hoare, 2000; Weladjj and Tchamba, 2003; Akankwasah, 2008). The continuation of consolidated land-use policy and the increasingly stringent control of crops grown in Rwanda (Huggins, 2013) may worsen this scenario in the coming seasons, especially as land pressure grows more acute. This may also hamper efforts aimed at reducing child malnutrition in the country, which has been identified as a pressing concern for Rwandan society (UNDP, 2007).

Aside from the monetary and opportunity costs investigated in this case study, the effect of crop raiding on the perceived agricultural resilience of those affected, and their ability to secure livelihoods as perceived by others, is likely more widespread around VNP than was uncovered in this study. The impact on these social assets is increasingly recognised as an important consequence of HWC (Barua et al., 2013).

Finally, this study also found that the batwa are regarded by park-adjacent communities as a threat to conservation and tourism and are commonly implicated as crop thieves. Though potentially highlighting a more engrained social stigma requiring further investigation, this attribution of culpability for crop raiding may simply be easier than largely unseen animal raiders. This was found in similar studies where visible elephants and thieves were more readily blamed for damage over unseen causes (Hoare, 2002; Tweheyo et al., 2005; Mc Guinness and Taylor, 2014).

8.2.2 The wider implications of this study for global HWC

Though this study found HWC to be one of a myriad of expressed livelihood limitations, in other studies where HWC was reported this represents the predominant agricultural restriction (Mulonga et al., 2003; Linkie et al., 2007; Thapa, 2010). Although this may position VNP in the minority of HWC case studies, I conversely posit that this study has more accurately characterised this conflict than the majority of studies thus far through its consideration of the social, political and ecological drivers of HWC. Considerable development and conservation research is conducted around protected areas globally, potentially resulting in the ‘problematisation’ of what may have formerly been regarded as an environmental condition (Fall and Jackson, 2002; Priston, 2008). Indeed, the use of the word ‘conflict’ has been described by some to bias studies from their outset (Peterson et al., 2010). By providing a scapegoat for other agricultural limitations and building the potential for compensation, previous studies may have created a hyper-awareness of crop raiding in regions surrounding protected areas globally (Linkie et al., 2007; Dickman, 2010; Karanth et al., 2012).
Having uncovered a broad range of crop raiding taxa in this study, the number of species involved in raiding and the numbers reported are consistent with other examples of lost agricultural productivity due to predation on land bordering forest in tropical Africa (Naughton-Treves, 1997; Naughton-Treves et al., 1998; Tweheyo et al., 2005; Hill and Wallace, 2012). Aside from reinforcing the argument that living next to a protected area exposes crops to the fauna it contains, the seeming abundance of forage within VNP (Plumptre, 1996; Robbins et al., 2001) supports the alternate argument that crop raiding is becoming increasingly selective as a feeding strategy (e.g. Chiyo et al., 2011), not through necessity but preference.

Finally, this study has uncovered an unexpected cultural dimension to HWC in its exacerbation of antagonism towards the batwa community, by reinforcing existing cultural divisions in resource access previously identified in Rwanda (Beswick, 2011) and neighbouring Uganda (Tumushabe and Musiime, 2006). This is a well-addressed cost of HWC in several global reviews (Manfredo and Dayer, 2004; Woodroffe et al., 2005; Dickman, 2010; Barua et al., 2013) though is rarely addressed at case study level, with limited exception in the developed (Peterson, 2002) and developing world (McGregor, 2005). The current study thus argues that greater consideration of the cultural implications of HWC be taken in conflict resolution, particularly with regard to those studies adopting conventional quantitative methods or involving disenfranchised communities.

8.3 The determinants of HWC
The number of societal and ecological factors dictating crop raiding prevalence in many other studies (e.g. Priston, 2008; Karanth et al., 2012) indicates that HWC is unlikely to vary with a single factor in this case study either. This study found significant variation in perceptions of HWC and actual crop raiding intensity along the boundary of VNP, with several factors significantly determining this variation, including gender of respondents and proximity to and location along the VNP boundary.

8.3.1 Implications of this study for conflict around VNP
This study found that the gender of park-adjacent residents significantly alters perceived exposure to crop raiding with females tending to underestimate this exposure. The drivers of this finding may be due to their greater presence in fields conducting agricultural work, reported in other cases to result in heightened exposure to the opportunity costs of HWC through reduced household time (Ogra, 2008).

Spatially, higher intensity raiding in areas close to the ravines of perennial rivers suggests that these landscape features facilitate easier access to farmland, as reported in similar studies of
mountain gorilla raiding around nearby Bwindi Impenetrable NP in Uganda (Hockings and Humle, 2009) and with buffalo raiding in neighbouring DRC (Blake, 2002). In this study, farmland close to ravines also overlaps with areas of high intensity raiding predicted through a priori modelling, showing their importance in predicting crop raiding in cases where monitoring systems may not exist. Furthermore, highly sloped areas leading to poorly maintained defences and better crop visibility from protected areas – allowing potentially-raiding species to both see and access palatable crops with lower chances of being seen – were found to experience higher levels of raiding according to the monitoring data. This important role of slope was reported by local farmers in the current study and has been noted in other montane tropical forest examples (Pérez and Pacheco, 2006; Linkie et al., 2007).

Though some studies have found insignificant linkages between distance to a protected area and conflict intensity (Gillingham and Lee, 2003), this study showed a strong relationship between VNP proximity and crop raiding, as noted in a previous study of this protected area (Plumptre, 2002). This strong relationship, as observed in other conflict case studies (Naughton-Treves, 1998; Hill, 2000; Kagoro-Rugunda, 2004; Linkie et al., 2007), can be explained by the absence of ecological refugia within the agricultural landscape and a lack of migratory species within northern Rwanda requiring pathways through park-adjacent land, which has driven HWC elsewhere (Nelson et al., 2003). Apart from raiding intensity, the suite of implicated species also changed with VNP proximity, similar to findings of other tropical examples (Nchanji, 2002) and a previous study of this protected area (Plumptre, 2002). In addition to proximity, the perimeter length and shape of park-adjacent cells were important determinants of exposure per cell in this case study, and have been identified in other examples of HWC (Gubbi, 2012). This indicates that application of equal mitigation measures across current cell-level administration may not adequately address conflict around VNP.

Aside from geographic and topographic drivers of HWC, the lack of correlation between agricultural forage availability based on reported crop cycles and the incidence of crop raiding is contrary to the findings of other studies. For example, strong relationships were found between the availability of high nutrient near-harvest crops and increased raiding (Gillingham and Lee, 2003; Tweheyo et al., 2005; Linkie et al., 2007). An explanation for this may lie in an understanding of the spatial variation of cropping trends, combined with the push factors of mammal distributions and the availability of preferred crop type, though collection of these data was beyond the scope of this study.

Though the planting proportions and combined planting levels of these crops did not affect crop raiding levels as measured through long-term monitoring, the effect of seasonality on HWC revealed that increased rainfall coincides with decreased raiding. Positive correlations have been
reported between rainfall and crop raiding intensity elsewhere (Parker and Osborn, 2006), or with a 1-month lag (Linkie et al., 2007), although the opposite seems to be the case for HWC around VNP. This could be explained by the reduced visibility of crops from the forest margin or the decreased stability of saturated steeply-sloped fields, especially for large cumbersome mammals. Anecdotal reports of rain encouraging animals to leave the cover of forest and raid fields are contrary to this and are unreported in the scientific literature (Blake, 2002). Despite the patterns and proportions of crops grown along the VNP boundary being difficult to identify, predictability of these trends may become easier with continuing land-use consolidation around VNP (MINAGRI, 2010).

Using these data on cropping trends and HWC magnitude, a model constructed to predict perceived exposure to crop raiding did not yield adequate specificity. Though several potentially-explanatory agricultural factors have been discussed above, such as types of crops grown, seasonal variations in crop choices and growth stage at the time of damage, a greater understanding of within-park drivers of conflict may give improved predictive power to the model. This includes a more accurate understanding of large mammal distributions and migrations across several time scales, including daily, seasonal and longer-term movements. This is particularly important when considering the international movements of elephant and mountain gorilla in the Virungas TBPA, driven by human conflict or poaching pressures (Plumptre et al., 2007b). Though measured in other HWC studies (Hoare, 1999; Sillero-Zubiri and Switzer, 2001; Sitati et al., 2003), this aspect of conflict around VNP has yet to be fully accommodated in susceptibility modelling, owing to a lack of data. Similar data gaps exist for forage availability and carrying capacities of the large mammals VNP supports, though the feeding ecologies of mountain gorilla social groups in the Virungas TBPA are comparatively well understood (Robbins et al., 2001; Robbins and McNeilage, 2003). Differing behavioural ecologies of raiding species should also be considered, as should the distribution of readily-available, high nutrient crops and the level of habituation of these species to humans (sometimes deliberately for tourism purposes). This latter issue was observed with golden monkeys and mountain gorillas in the current study and was blamed on deliberate tourism-based habituation efforts. The intelligence of these primates in comparison to ungulates and their ability to overcome mitigation efforts may also require consideration, as highlighted by Sillero-Zubiri and Switzer (2001). Conversely, variation of measured environmental and social factors around VNP may not be wide enough to provide explanatory power. Given the small length of the VNP boundary relative to tropical forest examples elsewhere (cf. Laudati, 2010), and the relatively homogenous livelihoods on its margins, this is plausible.
Finally, activities of the pyrethrum agro-industry in the area, unveiled as a prominent limitation to agricultural livelihoods in VNP-adjacent land, reinforce the importance of considering the wider political ecology of HWC and its impacts on development and conservation. In years when growing this non-palatable cash crop is required, exposure to raiding may be reduced and it may provide a buffer for other farms, as discovered elsewhere (Naughton-Treves, 1998; Hockings and Humle, 2009). However, farms obliged to grow pyrethrum may subsequently be required to plant potatoes as a monoculture under land-use consolidation restrictions (MINAGRI, 2010), reducing resilience to losses incurred by raiding, despite wholesale of surplus potatoes. Though pyrethrum provides year-round income, shortages of food and disposable income as a result of its cultivation were widely reported in this study, in addition to inequities in both market linkages and wholesale pricing of pyrethrum in Rwanda. This has reduced its popularity as a crop, a prominent finding of the current study and another recent investigation (Huggins, 2013). Thus, unless local support for pyrethrum cultivation is improved, in addition to maintaining production targets demanded by existing land-use agreements, the industry will continue to magnify the impacts of HWC. Conversely, a recent agreement (Ngarambe, 2010) that dried pyrethrum flowers will be imported may indicate a shift away from Rwanda as a growing country, with future focus on secondary processing. This could reduce pressure on park-adjacent farmers to fulfil growth targets and, depending on land-use consolidation pressures, may help to recover the resilience provided by intercropping systems against environmental perturbations, such as climate change (Lambin et al., 2003; Seo, 2010) and crop raiding (Fungo et al., 2013).

### 8.3.2 The wider implications of this study for global HWC

The findings of this study relating to the proximal and distal drivers of HWC have several implications which can be applied to global HWC more generally. First, the lower importance attached to crop raiding by female respondents around VNP may have uncovered a largely unexplored aspect of HWC; namely the social and psychological factors dictating perceptions of conservation and related conflicts (Dickman, 2010; St. John et al., 2010). Pertaining to individual human behaviours and priorities influencing perceptions, these include the differing social norms, moral obligations and cultural values of individuals. For example, the consideration of maternal priorities, such as postnatal care and child development, has been shown to influence perceptions of HWC (Barua et al., 2013). These factors are particularly important in the developing world where the impacts of HWC on livelihoods are greater.

Second, the important role of distance to a protected area, location along its margin and the variability of administrative unit size and shape has been highlighted by this case study. As a result, mitigation of HWC globally should be tailored to individual conflict situations (Hill et al.,
2002b; White and Ward, 2010), with care taken over the varying administration levels constituting or bordering these areas (Gubbi, 2012). For example, Karanth et al. (2012) have uncovered not only the spatial variability in incidence of conflict around a protected area, but also the differing administrative challenges of disbursing compensation. In some cases of tailored approaches, a separately-administered buffer zone is in place, allowing homogenous mitigation actions to be taken in high priority, park-proximate regions (Thapa, 2010; Karanth et al., 2012).

Third, land-use consolidation – uncovered in this study as an issue affecting perceived exposure to crop raiding and exacerbating its livelihood implications – is an increasingly prominent part of agricultural intensification in the tropics (Lambin et al., 2003) and is also promoted as viable mitigation of HWC in some circumstances (Muruthi, 2005). Food insecurity in Rwanda continues to rise, however (UNDP, 2007; Huggins, 2009). By showing the effects of consolidation regimes on HWC, the current study shows that measures aimed at reducing conflict must also secure livelihoods, in addition to preserving a valuable tourism and conservation asset.

Finally, the intervention of agro-industry found in this study has been shown elsewhere to affect local perceptions of crops which could otherwise establish buffer zones or alternative livelihoods (Priston, 2008). Thus, inclusion of this factor in the political ecology of developing world HWC is vital, considering increasing land pressures through population growth on the margins of protected areas (Wittemyer et al., 2008) and the acquisition of land rights by international agro-industry (Cotula et al., 2009).

8.4 The impacts of HWC on VNP tourism and conservation
The current study uncovered the attitudes of park-adjacent farmers to the conservation of VNP, its importance to the tourism industry and the effect of HWC on these relationships. Residents were found to understand broadly the ecosystem services VNP provides, such as the linkage between the intrinsic carrying capacity of VNP and crop raiding pressure. Conversely, the effects of this conflict on local support for tourism and conservation were highlighted in this study. This has wider connotations for protected areas globally, particularly those in use as nature-based tourism destinations or bordered by dense human populations.

8.4.1 HWC and VNP tourism
First, though not originally conceived as a community benefit tourism initiative per se (Simpson, 2008), community engagement around VNP was found to be substantial in comparison to other tropical examples (Belsky, 1999; Goldman, 2003). This includes the investment and intervention of conservation organisations, development NGOs and the RDB through the disbursement of
tourism revenue. Currently, revenue sharing around VNP contributes to large infrastructural projects or investment into pre-existing healthcare and education. Though this investment into facilities already associated with local government may increase the efficiency of benefit transfer from VNP revenue, one could argue that this replaces central government budget allocations for these; services that are at risk of being neglected in the future if park revenue decreases (Sandbrook and Adams, 2012). Additional to this, small non-infrastructure payments are distributed through cooperatives. However, this study found that these payments do not always reach those most at risk of HWC through the inequitable politics of local cooperatives and the low representation of park-adjacent residents within these. The efficacy of these small dividend-type revenue sharing payments has been questioned before (Sandbrook and Adams, 2012), meaning such payments may not be a fitting solution in this scenario, especially given their apparent inequity. Anecdotal accusations of local government and National Park officials withholding benefits have been found in several other studies of protected areas in the region (Archabald and Naughton-Treves, 2001; Sandbrook and Adams, 2012). Given the high population pressure around VNP and the inaccessibility of some park-adjacent areas, it may be ambitious to expect revenue sharing to reach all those affected. In the absence of clearer revenue sharing governance, however, infrastructural investment around VNP may be the most appropriate means of sharing benefits, promoting development and enabling tourism.

Second, the existing negative perceptions of the tourism industry identified in this study – caused by exclusion from habitats supporting species of tourism value, inequitable disbursement of tourism revenue and frustrations over tourism employment offered as an alternative to farming – are likely exacerbated by HWC losses. A more immediate impact of HWC on tourism was noted in this study with damages to a tourist lodge, and the threatening of tourists within, by a herd of buffalo. Lodge raiding by wildlife has been noted elsewhere (Sillero-Zubiri and Switzer, 2001) and, though limited to a single event in this study period, may become more frequent through increasing animal populations and a higher number of lodges near the VNP boundary. Similarly, other studies of conflict between human populations and nature-based tourism restrictions have revealed active removal of fences and continued grazing of livestock within protected areas (Buscher and Whande, 2007; Okello and D’Amour, 2008).

8.4.2 HWC and VNP conservation

The value of tourism linked to VNP is largely dependent upon the National Park’s effective conservation. The success of this conservation in the past three decades includes a 50% increase in mountain gorilla numbers (Robbins et al., 2011), which act as an important flagship species for conservation, and increasingly stringent control of resource extraction (Gray et al., 2010).
Additionally, the benefits of cross-border conservation through shared TBPA governance have been marked (Busch, 2008; Reyers et al., 2010).

The key to the success of conservation at a community level is local support (Emerton, 2001; Dickman, 2010). Despite significant conflict in this study surrounding crop raiding, sharing of tourism revenue, reduced use of park resources and removal from park-adjacent land, positive attitudes to conservation were observed. Other studies have uncovered anti-conservation sentiment (Linkie et al., 2007; Laudati, 2010; Thapa, 2010) as a result of similar conditions to this study, yet around VNP support for conservation remains high. The well-founded role of International NGOs in Rwanda (Storey, 1997), particularly towards biological conservation, may be a factor in this through instilling pro-conservation values that have established and promoted a lucrative tourism industry, without prior willingness to conserve. It is thus unclear whether communities feel morally obliged to conserve VNP, or fulfil the wishes of conservation NGOs and the RDB in order to maintain the benefits accruing from such support. Presumably the current costs of such values are outweighed by the benefits (Sandbrook and Adams, 2012), though the means by which these conservation benefits are distributed has the potential to significantly change perceptions of conservation efforts. Analyses of the findings of this study suggest that the promise of revenue sharing and compensation is used to encourage conservation and maintain lucrative tourism revenue streams. Conversely, the cessation of these benefits is threatened as a consequence of non-compliance, a coercive approach seen elsewhere in Government of Rwanda policy (MINAGRI, 2012b).

These conservation successes are not guaranteed, however. Past conflict in Rwanda has resulted in devastating losses of fauna and territory of previously-secure and well protected conservation areas (Kanyamibwa, 1998; Plumptre et al., 2001; Glew and Hudson, 2007). Thus, recent political unrest in the Virungas area between the DRC, Rwanda and Uganda (UN, 2012), including reported use of tracks through VNP to supply M23 rebel groups, is a worrying development for the Virungas TBPA. This is alongside regional changes in climate (WWF, 2006) and human population (PRB, 2012) which threaten mountain gorilla habitat through rising resource pressure (particularly water) on the margins of VNP and increase the risk of disease transfer through closer human contact (Sandbrook and Semple, 2006). Thus, though HWC may contribute to the threat to VNP conservation, it is likely to be overshadowed by wider political concerns affecting the fate of VNP.

Overall, though the carrying capacities of VNP fauna are unknown and the factors pushing animals to raid crops require more research, improved conservation of VNP resulting in higher animal numbers is likely to aggravate conflict. Furthermore, the increasing value of nature-based tourism, giving greater impetus to strengthen protection, will perpetuate this.
8.4.3 The wider implications for tourism and conservation

Nature-based tourism has the potential to improve the lives of subsistence communities living on the margins of protected areas in the developing world, by providing employment, alternative livelihoods or direct financial dividends (Lepp, 2007; Mackenzie, 2012; Sandbrook and Adams, 2012). Though exclusion from protected areas on conservation grounds limits resource availability, ecosystem service preservation and continued tourism benefit sharing both aim to offset this (Naughton-Treves et al., 2005; Simpson, 2008).

Caution is advised, however, when considering the extent and nature of community feedback from tourism and conservation in the developing world. As Emerton notes, “it is not self-evident that sharing wildlife revenue as development benefits will alone lead to a net economic gain for communities” (2001, p.215). Among the factors limiting the success of tourism initiatives aimed at benefiting communities, the detrimental effect of HWC is well documented. This includes social division through inequitable allocation of tourism benefits and worsening livelihood pressures (Weladji and Tchamba, 2003; Adams and Hutton, 2007), as was found in the current study. The finding that revenue sharing around VNP is not reaching those most affected by HWC reflects the skewed distribution of nature-based tourism benefits elsewhere (Belsky, 1999; Emerton, 2001; Mackenzie, 2012; Sandbrook and Adams, 2012). Whether this is through inefficiencies in the revenue sharing process, a lack of social network linkages providing access (Belsky, 1999), or non-commutable benefits, the transaction costs, or leakage, in this process are evidently too high (Emerton, 2001; Sandbrook, 2008).

Despite a lack of clear and equitable distribution of tourism and conservation benefits, the rhetoric observed around VNP of increased ‘harmonisation’ to achieve local empowerment and conservation goals has been highlighted in African great ape conservation generally (Sandbrook and Roe, 2010). Furthermore, the role of international NGOs in influencing the conservation values of marginalised communities has been raised as an increasingly important facet of political ecology (Adams and Hutton, 2007), for example in Zimbabwe (McGregor, 2005). However, additional examples of conservation perpetuating conflict, justified by tourism gains, are lacking in the wider literature. Thus, the fact that decisions to conserve may not be based on locally-held worldviews, wildlife value orientations or benefits accrued adds value to those studies which address the political ecology of these conflicts. The findings of this study also raise the broader question of whether negative attitudes to conservation or tourism actually lead to negative actions against conservation, or merely foster quiet discontent (Dickman, 2010). If not, funding pro-farmer schemes or encouraging revenue sharing may be of no benefit, as highlighted by St. John et al. (2010). Having said this, a review of forested protected areas in central African found that the success of conservation programmes was not dictated by the local support they received.
This has worrying implications for communities residing beside these protected areas (VNP included), if development is not seen as a prerequisite of successful conservation.

Although the complexity of striking a win-win scenario in development and conservation (and the tourism value which often underpins this conservation) lies in considering the multitude of stakeholders involved, including governments, the private sector, NGOs and communities (Simpson, 2008), this case study has demonstrated that communities most exposed to loss as a result of forgoing use of protected areas are often under-considered by conservation. Consequently, by lessening support for conservation and tourism, HWC compromises the ability of conservation-related benefits (such as tourism revenue) to aid the development of economically marginalised communities.

8.5 Current mitigation and future solutions

This study found that prevention and mitigation of HWC in the form of crop raiding is limited to the guarding of crops and the construction and maintenance of physical barriers of varying quality and effectiveness. This section discusses the selection and usefulness of these mitigation efforts and compares these to the efficacy of similar strategies adopted elsewhere. Additionally, this discussion shows how the findings of these studies may aid mitigation of HWC where a protected area borders areas of high population density more generally.

8.5.1 Current mitigation in use around VNP

Actions aimed at preventing or mitigating crop raiding by forest dwelling animals around VNP were limited to active guarding and barrier construction. Though found to consume a significant portion of time and money, limited discontent was expressed over the necessity to guard crops in this study, and was seen as an accepted cost of living close to the benefits provided by the forest. However, given that guarding was not associated with a reduction in expected loss, the decision to guard may be seen as a reaction to heightened expected losses and is likely imposing additional financial and opportunity costs (Davies et al., 2011; Barua et al., 2013). The finding that school attendance was not affected by this is in contrast to similar cases where children have been used to guard crops (Hoare, 2002; Nelson et al., 2003; Kagoro-Rugunda, 2004).

Though the chasing of animals from farmland is a common strategy to deter animals from crops (Osborn and Parker, 2003; Strum, 2010), restrictions on this in Rwanda, under presumed greater risk of transmitting human diseases to the mountain gorilla population, serve to worsen losses. This was observed around Bwindi Impenetrable National Park, Uganda, where not only are
restrictions in place but primates quickly habituate to chasing methods (Hockings and Humle, 2009). Linked to this, the lack of retaliatory killings in comparison to reports from elsewhere (Muruthi, 2005; Reynolds, 2005) is most likely explained by the stringent controls on interacting with VNP fauna when ranging outside of the park. Though these controls provide some protection from disease transmission, the longer-term adverse effects on perceptions to tourism and conservation around VNP may eventually outweigh benefits of reduced spread of disease. Similar restrictions are also in place in Uganda, with gorillas (Laudati, 2010) and other primates (Naughton-Treves, 1997) generating similar animosity towards protected areas.

Aside from the guarding of crops, the use of physical barriers to protect land was prominent, though its extent and quality was uneven. The close association between the quality of constructed boundary defences and large mammal raiding intensity may show a response to heightened crop raiding by these species, necessitating strengthened defences. Conversely, current physical barriers may be effective in preventing raiding levels from being considerably higher than observed levels in park-adjacent land. The low quality of wall in other regions may indicate an acceptance of the ineffectiveness of barriers in impeding primates (Hockings and Humle, 2009), or it may represent other limitations to its strengthening, such as local shortages of raw materials or man-power.

The type of VNP species committing the crop raiding observed in this study is also forcing extensive barrier investment. The prominence of buffalo raiding around VNP, for example, has led to a programme of trench extension, though the cost and maintenance of such large scale mitigation efforts continues to limit their implementation. This was found in several other cases studies where a lack of funds and expertise has limited the use and quality of more effective barriers (Thapa, 2010; Gubbi, 2012). White plastic bags are also in use around VNP as fladry/scarecrows, a common practice elsewhere (Hayward and Kerley, 2009; White and Ward, 2010), especially against ungulate raiding and in combination with wire fencing. Restrictions on the use of plastic bags in Rwanda may prevent this inexpensive action from becoming more widespread, however.

8.5.2 Recommended mitigation in light of current findings
Several recommendations for mitigation can be made based on the findings of this study. The use of trenches elsewhere, as a barrier against larger and less nimble mammals, has been highly effective (Davies et al., 2011; Mackenzie, 2012). Though a costly solution in terms of labour and materials, this is significantly cheaper than electrified fence solutions in use elsewhere (Thouless and Sakwa, 1995; Gubbi, 2012). Furthermore, the continued use of umuganda civic labour for wall and trench construction will increase the extent and quality of these defences, though
participation in this is often coercive. Alternatively, though the positioning of bee hives along the VNP boundary increased honey yields, this has been shown elsewhere to also deter elephants (King et al., 2007) and could be inadvertently reducing elephant raiding along those parts of the VNP boundary where hives are present already. Thus, in addition to diversifying livelihoods, bee hives may also provide conflict mitigation services. Mitigation of raiding by the intelligent primates of VNP is more challenging, however, and may require significant investment into electric fences, extensive trenches, or novel mitigation. For example, conditioned taste aversion has been used with some success to deter small mammals in general (Baker et al., 2007) and African primates specifically (Hockings and Humle, 2009). Only significant investment, however, will allow these alternative mitigation measures to be a comprehensive and semi-permanent solution.

The magnitude of buffalo raiding in this study and their association in this and other studies with water courses and ravines (Blake, 2002) indicates that targeted investment of physical barriers around gaps in defences associated with ravines may be an effective use of limited resources. This may include wire fences or wooden stakes positioned across water courses, though the flashy flow of tropical mountainous rivers such as those in VNP would likely result in considerable maintenance costs. In addition, some of the ravines exiting VNP are extremely wide. Findings of this study also suggest that many gaps at or near ravines are deliberately left open to maintain resource access. The fact that ravines dissecting the boundary of VNP also allow for greater penetration into farmland further from the forest edge means that sealing these weak point is of high priority.

The success of dogs as livestock guards may also present a solution for crop guarding (Naughton-Treves, 1998; Sillero-Zubiri and Switzer, 2001), particularly against nocturnal raiding. Trained dogs are currently in use as an anti-poaching measure in neighbouring Virungas National Park, DRC (ICCN, 2012) indicating that the use of dogs for crop protection may also be viable along the VNP boundary. However, concerns over disease transmission between existing domestic and feral dogs in the region of VNP and the gorilla population may prevent this.

The implementation of appropriate buffer crops may also reduce the tendency of forest dwelling animals to damage crops (Thapa, 2010). Tea and coffee, used elsewhere for this purpose (Mulley and Unruh, 2004; Chiyo et al., 2005), grow well at high altitudes and could provide a viable alternative to the stringently-controlled pyrethrum industry. This is dependent, however, on firm market linkages for these crops, and the impetus of current agro-industry to initiate this change in spite of the growing value of pyrethrum derivatives (Huggins, 2013). A buffer of eucalyptus and cypress plantations are currently being established in several VNP-adjacent territories, though
may merely provide secondary habitat for raiding species, extending raiding range further into farmland (Hill, 2000).

Aside from the physical separation of forest-dwelling fauna from agricultural land, softer solutions have been proposed to mitigate the livelihood impacts of crop raiding (Hayward and Kerley, 2009). In other less populated areas, regulated use of protected area resources coupled with softer boundaries may offer consolation to HWC losses (Logan and Moseley, 2002; Hockings and Humle, 2009). However, this is unlikely to be an acceptable treatment for VNP, considering the growing human population of northern Rwanda and the increasingly lucrative tourism industry which may be threatened by mixed use solutions. Pressure from conservation NGOs may also provide external justification for these restrictions, as has been accused of Rwandan public private partnerships previously (Huggins, 2013). These shortcomings in stakeholder involvement and participatory problem resolution have similarly affected other community-based mitigation strategies (Webber et al., 2007).

Smaller scale local politics of mitigation is an additional consideration for its future implementation. Crop raiding occurs along the entire boundary at high intensity, as revealed in the current study. However, the concentration of high quality boundary defences in areas bordering central regions of VNP could be seen as a political action, based on the location of most tourism activity to showcase the affirmative action being taken by VNP management. Thus, an alternative to finding novel prevention and mitigation may simply lie in the expansion of current measures beyond the ‘critical zone’ of conflict.

Though not attempting to prevent conflict, compensation payments for crop damages have been recommended as a means of reducing the impact of losses incurred through HWC (Adams and Hutton, 2007; Laudati, 2010). However, though currently under development in Rwanda at the time of this study, this scheme is likely to be hindered by the same limitations of similar programmes in the developing and developed world alike (Nyhus et al., 2003; Boitani et al., 2010). For example, the inherent moral hazard of compensation schemes was observed in this study, where those eligible for compensation were less willing to invest in mitigation measures, and will likely affect any implemented compensation scheme (Bulte and Rondeau, 2005). Similarly, the transaction costs of verification and programme management may be prohibitive (Mackenzie, 2012), or may begin to denude revenue sharing investment benefitting entire park-adjacent communities. Additionally, compensation schemes often only cover large damage events (Karanth et al., 2013), which would exclude the significant number of smaller raiding events reported in this study. Reports since data collection of this study ended suggest that the compensation process is highly bureaucratic and is socially divisive as it requires travel to the capital city 80km
away. Additionally, the inequities of revenue sharing payments unveiled in the current study may predict unequal access to this compensation programme.

Finally, increased agricultural autonomy could provide an effective coping mechanism for crop raiding around VNP. Despite being identified as a key prerequisite to successful conservation and conflict resolution generally (Emerton, 2001; White and Ward, 2010; Sandbrook and Adams, 2012), encouragement of agricultural autonomy is rarely included in HWC treatments. Expressed as a leading limitation to livelihoods in this study, a lack of agricultural autonomy may also render farmers less resilient to crop raiding losses by obliging monocultures of high risk crops. Other studies of primate crop raiding have shown reductions in overall monetary loss when crops are mixed (Fungo et al., 2013). Even though VNP-adjacent farmers may not possess actual control over land-use, efforts by local government and agro-industry to give a superficial impression of behavioural control to these farmers may have a positive effect on perceptions of exclusionary VNP conservation and the HWC costs associated with this (St. John et al., 2010; Allendorf et al., 2012). Given the focus of Rwandan national agricultural policy on increasing exports of high value crops (RoR, 2000), a reversion to small-holder mixed cropping is extremely unlikely. That said, dispensations based on ecological and socioeconomic conditions have been given (MINAGRI, 2012b) and may be of value for VNP-adjacent farmers at risk of crop raiding.

Regardless of mitigation method, Fall and Jackson (2002) have outlined the need to increase research budgets and reduce run-in times for novel approaches. This may, admittedly, be a reasonable recommendation in the developed world. However, in Rwanda where funding is limited and aid investment can be highly politicised, increased efficiency of implementation is not envisaged in the near future. Thus, some have highlighted the successes of shifting from state-controlled conservation to regulated commercial and landholder involvement (Emerton, 2001). For example, the successes of Akagera National park, in eastern Rwanda, of growing visitor numbers (RDB, 2011), strengthening boundary defences and increasing faunal populations (Macpherson, 2013) have all occurred since its recent semi-privatisation. It thus presents a successful model of public private partnership which could be considered for VNP.

8.5.3 The wider implications of these findings for HWC mitigation

In light of a comparison of this study’s findings to examples of HWC mitigation elsewhere in the developing world, several wider implications can be discussed.

First, this study has shown that the guarding of crops is a preferred, effective and sustainable mitigation strategy which, depending on conditions, can have minimal opportunity costs. The effectiveness of guarding is likely heightened in highly populated regions where one guard may protect several farms. Given the disproportionately high population growth rates on the borders
of protected areas globally (Wittemyer et al., 2008), this is an important finding for future conservation and development conflicts.

Second, this study has confirmed the findings of other studies (Nelson et al., 2003; Hockings and Humle, 2009) that physical barriers have limited efficacy in impeding all of a diverse suite of raiding species. In addition they consume considerable time and resources, and are as much a visible declaration of a fortress boundary as they are a public relations tool for conservation and tourism. For primate raiding specifically, alternative coping strategies, including toleration of HWC by affected subsistence farmers, should be considered over complicated physical defences (Fall and Jackson, 2002).

Third, the suite of mitigation efforts put in place around protected areas generally needs to be tailored not only to the explicit nature of the conflict and the socioecological processes dictating this, but also to the political ecology of each conflict, including the various vested interests of stakeholders and uneven distributions of existing mitigation.

Finally, the findings of this study indicate that caution must be taken with compensation schemes, especially in communities not familiar with such payments or where verification of claims is difficult. The risk of moral hazard and complacency is high in these scenarios (Bulte and Rondeau, 2005).

### 8.6 The potential of an insurance scheme

The findings of this project suggest that conventional mitigation efforts may not be adequate to reduce the livelihood costs of crop raiding around VNP. Thus, evaluating the acceptability of a locally-funded insurance scheme to dampen these HWC impacts was viewed as an important exercise.

#### 8.6.1 Feasibility for VNP

Investigating the potential for an insurance scheme around VNP confirmed that local shared funds to dampen livelihood perturbation, such as remittances regulated by social networks and nationwide health insurance schemes, already exist in Rwanda (Verpoorten, 2009; Benda, 2012). Thus a common fund to mitigate crop raiding losses may be acceptable to VNP-adjacent farmers and has been recently suggested as a coping mechanism for the emerging limitations of land-use consolidation (MINAGRI, 2012b), though further details on how such a scheme would operate are lacking.
The CV component of this study found a strong positive correlation between the second dichotomous choice bid value presented and levels of acceptance. This is counterintuitive as a reduction in willingness to participate is expected with increasing price (Hanley and Barbier, 2009). This finding may be explained through an assumption by local farmers that, with increased monthly premium payment and overall insurance fund size, the likelihood of the scheme proceeding increases. Conversely, it may also be accounted for by the status associated with participation in an expensive insurance fund, akin to the conspicuous consumption of burdensome or Veblen goods (Veblen, 1899; Wood, 1993). Though valuation of an insurance premium function was not possible owing to these unexpected bidding trends, post-hoc investigation of acceptability and mitigation preferences revealed that most would rather pay into local insurance funds than continue to invest in mitigation. This preference for the proposed insurance fund over conventional mitigation based on guarding and physical barriers may similarly be explained by the status attached to it.

This study has therefore highlighted the lack of faith in expensive physical barriers and their labour-intensive maintenance. It additionally shows a lack of confidence in future compensation schemes proposed by the Rwandan government. Though this could be a consequence of greater belief in an insurance scheme, it may also be accounted for by the social desirability bias of concurring with a foreign researcher, as highlighted in previous valuation exercises (Loureiro and Lotade, 2005).

8.6.2 Potential for global application

Common fund solutions to environmental perturbation have been proposed in developed world scenarios previously (Clark et al., 2000). In less developed economies, the local-collective solution to HWC has also been identified as a potential means of mitigating livelihood impacts (Hill, 2000), though the absence of technical/administrative capacity, cash economies and data on loss events have restricted their use in the developing world (Morrison et al., 2009). One example to protect against livestock depredation by snow leopards (Uncia uncia) in Pakistan is well-supported locally and is 50% funded by private ecotourism revenue (Hussain, 2000). A similar scheme in Namibia, including local fund structures to reduce strategic exaggeration of losses, is well supported locally and has downgraded the true extent of HWC as an issue by highlighting its infrequency (Bowen-Jones, 2012). However, the reliance on tourism for 50% of the insurance fund in both examples renders them vulnerable to fluctuations in tourism numbers as a result of regional political instability. This is an important implication for similar potential schemes to tackle crop raiding around VNP. Furthermore, insurance schemes elsewhere often require state-subsidies, are more akin to national compensation schemes and are open to exaggeration and exploitation (Kagiri, 2002; Nyhus et al., 2003; Bulte and Rondeau, 2007). For these reasons, maintaining a minimal
operational size of scheme would reduce the desire to cheat such a system, as observed by Hussain (2000). The inclusion of this stipulation in the CV scenario presented in the current study may have increased its acceptance and should be considered in its more widespread adoption. An additional limitation to general insurance schemes globally is a lack of coverage and availability of data allowing estimation of risk, known as information asymmetry (Kunreuther et al., 2013). Collection of sufficient monitoring data to build a predictive risk model, such as those collected through the current study, reduces the chances of a scheme being rejected by at-risk farmers due to these information limitations, by allowing realistic and acceptable premium costs to be calculated.

Overall, comparison of the findings of the current research with operational trials of insurance schemes suggests that local collective funds against crop losses are a sustainable solution for similar conflicts, where sufficient autonomy exists to allow such funds to function. This study has, however, highlighted that participation in such funds may be driven by both false presumptions of its efficacy and by perceived increases in social status upon participation.

8.7 The constraints of HWC on conservation and development

Using the case study of VNP, this study has highlighted the significant impacts had by HWC on the conservation of valued biodiversity and the development of economically-marginalised communities living near protected areas.

First, the findings of this study suggest that wider (distal) decisions taken at national, regional and international, levels seem as influential as local (proximal) factors in driving conflict and its associated effects on development and conservation, contrary to current HWC assessments focussing on exclusively-proximal drivers. In this way, HWC may be understood better in terms of an assemblage of heterogeneous strands of cause and consequence, with wide socio-spatial and temporal variability, rather than a simple scalar network (Allen, 2011; Anderson and McFarlane, 2011). HWC is inherently a conflict of differing human priorities for natural resource use (Manfredo and Dayer, 2004; Peterson et al., 2010). Therefore, though ecological push factors may prime HWC on the margins of protected areas, the form, level and extent of HWC is predominantly determined by human decisions often taken on wider stages. Given that land bordering protected areas in the developing world tends to be farmed at a higher density than other areas (Wittemyer et al., 2008) and is occupied by poorer residents who may be less represented in natural resource governance (Plumptre et al., 2004; Bush et al., 2010), decisions affecting the manifestation of HWC are therefore rarely made by those at risk but by more
remote decision makers such as government officials or regional conservation managers, including those decisions made in the past by a variety of actors. This is reflected in the findings of this study and implies that control measures to limit the impact of HWC on conservation and development may need to prioritise analysis of these distal drivers of conflict such as government policy and the intervention of private industry. Furthermore, the complexity of characterising the ecological push factors in cases of HWC also suggests that efforts may be better aimed at distal political influences.

Second, the introduction of locally-funded insurance, a seemingly accepted and popular means of reducing the impact of HWC in this case study, presents a mechanism for decoupling conservation and development from the constraints imposed by HWC, by removing the dependency of communities on compensation as a form of revenue sharing. Furthermore, recent findings from central African protected areas, showing that the success of conservation programmes rarely depends on local support (Struhsaker et al., 2005), indicate that conservation efforts may need less local support than previously thought to ensure success. Worryingly, this decoupling may result in the downgrading of HWC mitigation as a conservation and development priority. Indeed, the re-emergence of fortress conservation as a preferred conservation strategy in some cases (Buscher and Whande, 2007) may reflect acknowledgement of this and the fear of diluting conservation objectives with development concerns (Rutagama and Martin, 2006).

Finally, though often assumed to be the predominant issue facing marginalised communities living close to protected areas (Woodroffe et al., 2005), in this case study HWC was one of a myriad of problems limiting development and therefore threatening conservation. The surprising nature of this finding may be based on a dangerous a priori assumption that HWC is a prominent issue affecting subsistence farmers. The reliance on preconceptions such as this, based on the world view of the researcher, has been highlighted recently as a shortcoming of the political ecology approach to environmental challenges (Penna-Firme, 2013) and suggests that an alternative framework may be required, such as that of event ecology - which in this context considers the actions of the past and their continuing effect on HWC and perceptions of this - as well as the present web of associations constituting political ecology. Furthermore, framing of HWC, its drivers and its consequences as a heterogeneous assemblage may strengthen understanding of conflicts and our ability to resolve them (Allen, 2011). Additionally, heuristic principles (including common sense, local knowledge and rough estimation) may be applied with greater success than any of the above more complex and research-heavy modes of interdisciplinarity (Lengwiler, 2006). Though not guaranteed to be optimal, it may reduce the tendency to reinvent the wheel in conservation (St. John et al., 2010).
Overall, HWC represents a substantial limitation to the livelihoods of those living close to protected areas. However, preventable conditions imposed by distal protagonists, such as the limitations on revenue sharing by national governments and restrictions on agricultural control imposed through a variety of mechanisms, have forced communities to use the grievance of HWC as a tool for gaining development benefits promised by the nature-based tourism industry and the conservation underpinning this.

8.8 Methodological limitations

Several methodological limitations may have affected this study, in the collection and analysis of data and the interpretation of findings resulting from these data. The following considerations were controlled for where possible and where knowledge of their influence was known in advance.

For qualitative investigation tools such as focus groups, subjective judgements are often required in the interpretation of findings (Knodel, 1993). Some of these interpretations may have been unduly influenced, however, by the research assistant and focus group facilitator (Müller, 2007). The wide socioeconomic and cultural gap between both members of staff and respondents in focus groups and administered surveys may have impacted responses (Loureiro and Lotade, 2005), though division of focus groups by location and gender was intended to reduce this influence. It was hoped that this would also give a more accurate description of conflict along the margins of VNP and allow its broader application as a case study of conflict by providing internal and external validity (Creswell, 2009; Drury et al., 2011). My own positionality may have also affected responses in focus groups and surveys, beyond reflexive controls over such biases described in the methodology (Rose, 1997).

Though local elites represented important gatekeepers, the potential influence of these in preliminary investigation, focus groups and surveys was significant. Following post-hoc investigation in other studies, some participants felt that local actors unduly influenced the proceedings of focus groups and surveys (Sandbrook and Adams, 2012). Efforts were made in this study to restrict access, however their influence was still felt in some cases through fear of participation or expression. These included 'big men' who controlled market linkages, military commanders and their reported network of local informants, VNP staff and local administration. In some instances, however, their inclusion was a condition of access to these communities.

This study found CV an effective method of eliciting perceived values of conflict mitigation strategies, regardless of the unexpected trends in data obtained. However, the CV method of eliciting WTP has been extensively critiqued, having both proponents (Boxall and Beckley, 2002;
Poe et al., 2002; Hanley and Barbier, 2009; Hunter et al., 2012) and strong opponents (Kahneman and Knetsch, 1992; Vadnjal and O’connor, 1994). For example, though Hanley et al. (2001) claim that WTP figures would be predominantly biased in favour of wealthier potential beneficiaries, I disagree and regard a well-controlled valuation technique, which accounts for wealth, time and space as a function of any WTP distribution, as being an acceptable representation of variation. A more worrying concern of WTP methods is the cultural differences these methods may not control for (Ressurreição et al., 2012). Though cultural homogeneity was assumed based on prior investigation and local knowledge, it could have played a factor, particularly when dealing with a potentially different ethnic composition closer to Uganda versus closer to the DRC. Furthermore, general limitations of face-to-face interviewer positionality have also been highlighted in valuation studies (Loueiro and Lotade, 2005), which likely affected the results of this CV study.

Finally, with regard to monitoring, data collectors were recruited locally to allow access to local knowledge and obtain more accurate reports. However, this may also have allowed for influence over reporting, especially when estimating area damaged under expectation of compensation, as found in previous studies (Siex and Struhsaker, 1999; Nelson et al., 2003).

8.9 Future research

This study has obtained a comprehensive understanding of how HWC impacts upon conservation and development efforts, using the case study of VNP. The use of a political ecology approach has also allowed consideration of both the proximal and distal drivers and consequences of this conflict. Further research into specific areas beyond the scope of this project could, however, give greater insights into this conflict and may strengthen its use as a case study in other developing world wildlife conflicts.

First, several proposed prevention and mitigation measures may be tested along the margins of VNP. A trial of less palatable crops in park-adjacent land with representative variation in market connectivity, socioeconomic status and risk of crop raiding (as predicted by this study) should be conducted, similar to trials conducted in Uganda (Hockings and Humle, 2009). Further, a study of the efficacy of park-adjacent eucalyptus plantations at reducing exposure to crop raiding is required and may be obtained through further analyses of this study’s monitoring data. Similarly, a socioeconomic analysis should be conducted into the feasibility of tea and coffee plantations as a buffer, though lessons from this study regarding the coercion and control exacted by the pyrethrum industry must be observed in future agro-industry involvement.
Second, in order to better analyse the distribution of revenue sharing (which this study showed requires significant revision) and local engagement with tourism activities around VNP, the analysis template of active versus passive involvement devised by Sandbrook and Adams (2012) may be adopted. Through this so-called access analysis, streams of active and commutative benefits could be identified and the efficacy of these analysed. This technique was unpublished when developing the methodology of this study.

Third, given the complexity of HWC causes and consequences, and the requirement to consider ecocentric worldviews, funding and human development priorities, future studies should develop a decision-making process to mitigate HWC based on existing stakeholder knowledge and the experience of conservation practitioners. These data syntheses are increasingly integrated with probability statistics using Bayesian Network analyses (Marcot et al., 2006), which have demonstrated more efficient decision-making capabilities than existing conservation practices (Stewart et al., 2013). The characterisation of HWC around VNP provided by this study may allow the future development of such a mitigation decision-making tool for HWC, especially given the data paucities and uncertainties of crop raiding at present. This could allow decisions to be made on current knowledge which are subsequently fine-tuned with continued research (Aalders, 2008). A potentially important factor in such tool building may be the point at which tolerance for HWC is no longer provided for through tourism revenue sharing. Some argue that this metric characterises the real extent of HWC, in terms of social impact and a desire for change (Gortazar et al., 2010). Future work may thus involve quantification of tolerance for crop raiding around VNP, potentially including a threshold-style valuation technique similar to the PPM used in the current study.

Forth, this study revealed significant spatial variability in ordinary least squares regression of suspected conflict determinants. Geographically-weighted regression (GWR) could be used to characterise this spatial variability in variable relationships (Fotheringham et al., 2002), facilitating the application of site-appropriate mitigation measures along the boundary of VNP. More accurate quantification of financial loss resulting from each raiding foray is required to allow for GWR. Though attempted in this case study, quantification of loss per raid was not possible owing to the difficulties outlined earlier in this chapter, including a broad lack of non-gorilla ecological understanding. In particular, much greater information is required on buffalo (as the species responsible for most damage) movements and ranges within VNP, which may be achieved through sampled GPS/radio tracking, though trials of this technology in dense forested environments have yielded varying success (Blake et al., 2001; Blake, 2002).

Finally, the Virungas TBPA presents the unique case of a protected area spanning three nations in a resource constrained region affected by increasing population pressures. Though not pursued
here owing to logistical limitations and security concerns, a comparison of the political ecologies at play in the three nations co-governing the Virungas TBPA could provide a useful case study for application in existing conflicts elsewhere, especially given the emergence of the TBPA conservation model in developing world conservation.
9. Conclusion

9.1 Overview
The aim of this study was to establish the extent to which HWC constrains both conservation and development around protected areas, using Volcanoes National Park (VNP), northern Rwanda, as a case study. The five research objectives (ROs) implemented to achieve this were:

RO1 – Determine the form, level and range of human-wildlife conflict experienced by farmers adjacent to VNP

RO2 – Establish the likely determinants of conflict, including spatiotemporal variation

RO3 – Determine the impacts of HWC on VNP tourism and conservation

RO4 – Ascertain the nature, extent and effectiveness of current mitigation and appraise potential future solutions

RO5 – Assess the potential of an insurance scheme to mitigate losses due to conflict

9.2 The findings of this study
The following section summarises the overall answer to the research aim of this study. Subsequently, the findings of each individual research objective designed to achieve this aim are expanded upon.

9.2.1 Overall aim
This study has shown that;

1. HWC is a prominent livelihood limitation for those farming land adjacent to protected areas, though this is likely to be one of a number of equally important livelihood restrictions experienced.

2. the nature and magnitude of HWC does not equally affect all those potentially exposed, particularly based on distance to protected area

3. in addition to proximal ecological drivers, this conflict also stems from more distal elements of the political ecology of HWC, including a national economic incentive to control agriculture, the continued intervention of agro-industry and the preservation of tourism revenue.
4. agricultural restrictions perpetuate HWC, resulting in limitations to both development and conservation goals.

9.2.2 The specific findings of this study and their wider implications
This study has addressed its objectives by considering the social, political and ecological drivers of conflict, giving a unique and arguably firmer understanding of HWC around VNP and its effects on conservation and development. Further, the current study has deliberately adopted a mixed methods approach to achieve these objectives, as comparisons with previous studies adopting a singularly quantitative or qualitative approach have highlighted their shortcomings in capturing the variability in HWC causes and consequences. Among the limited number of HWC studies using a mixed methods approach, the current study is one of few which consider the political ecology of HWC. Using the above approach, and through appropriate reference to current literature, this study has made an appreciable and original contribution to the field of conservation and development.

RO1 - Determine the form, level and range of human-wildlife conflict experienced by farmers adjacent to VNP
This objective sought to determine the extent and significance of HWC around the boundary of VNP, and the level to which actual extent and significance differed from that claimed by farmers and conservation workers. HWC around VNP varied spatially and over time. Though damage to a selection of crops was caused by a wide suite of crop raiding species, the majority of damage was caused by a small number of species, to a limited number of crops. Moreover, perceived seasonal crop raiding intensities differed by one month from those measured in monitoring. Costs associated with HWC included financial loss from crop damages, opportunity costs of active guarding and potential cultural animosity. The reported abundance of forage within VNP supports the argument that crop raiding is becoming increasingly selective as a feeding strategy of forest-dwelling fauna, not through necessity but by preference. This case study highlights the importance of considering the social, psychological and financial effects of HWC. This study also argues that greater consideration of cultural implications be taken in studies of HWC generally.

RO2 - Establish the likely determinants of conflict, including spatiotemporal variation
Using a mix of triangulated qualitative data and quantification through administered surveys and monitoring, this objective sought to identify the key drivers of HWC on the margins of VNP. Gender of respondents significantly affected perceptions of crop raiding, though socioeconomic class did not. Factors relating to land-use and land tenure were the most prominent determinants of HWC, as expressed by exposed farmers and modelled using quantitative data. These factors included ownership of land, control of agriculture and the involvement of private agro-industry. Location along the boundary of VNP and proximity to its edge were also positively correlated with
crop raiding intensity. Though local understanding of within-forest push factors affecting crop raiding was broad, a lack of data prevented empirical testing of this.

These findings suggest that better prediction of where HWC will occur may lie in an understanding of the spatial variation of cropping trends, combined with the push factors of protected area ecology. The significance of space on the variability of HWC intensity implies that the application of uniform mitigation measures across the entire edge of protected areas may not adequately address conflict. This study further suggests that unless local support for distal land-use decisions is improved, in addition to maintaining production targets demanded by existing land-use agreements, agro-industry and government land control will continue to magnify the impacts of HWC. Measures aimed at reducing conflict must thus secure livelihoods in addition to achieving economic and conservation goals.

R03 – Determine the impacts of HWC on VNP tourism and conservation
This research objective attempted to assess the impact of HWC around VNP on the conservation of the park and support for tourism activities. As a lucrative earner of foreign revenue, tourism of VNP is facilitated by the successful fortress conservation of the National Park. Sharing of the revenue generated through this, however, was found to be limited and does not reach most residents living within 1km of the park boundary. Despite an acknowledgement that tourism provides national benefits, local benefits such as employment opportunities were rarely recognised. Though support for tourism and the associated restrictions on forest use seem high, HWC reduces this by perturbing livelihoods without adequate reciprocal benefit in the form of equitable revenue sharing. This study further shows that, although HWC may threaten conservation, it is likely to be overshadowed by larger facets of political ecology, such as national tourism revenue gains and international conservation pressure. The increasing value of nature-based tourism, giving greater impetus to strengthen protection and increase faunal populations, will perpetuate conflict between communities exposed to HWC and tourism. There are worrying implications for communities residing beside these protected areas, if local support is not seen as a prerequisite of successful conservation.

R04 – Ascertain the nature, extent and effectiveness of current mitigation and appraise potential future solutions
This objective aimed to identify the means by which local farmers and VNP management prevent HWC or mitigate losses as a result of this conflict. Active guarding was adopted as the dominant mitigation measure. In addition, a stone wall of varying quality and extent was in place to impede larger mammals, though only the strongest category of this wall seemed effective in impeding crop raiding ungulates. Crop guarding and the construction of boundary defences were found in this study to result in substantial expenditure of time and money, though opportunity costs were
low in comparison to other studies. The findings of this research objective have several broader implications. Physical barriers in general have limited efficacy in impeding all of a diverse suite of raiding species. The guarding of crops is a preferred, effective and sustainable mitigation strategy in the developing world which, depending on conditions, can have minimal opportunity costs. An alternative to novel prevention and mitigation may thus lie in the expansion of currently employed measures beyond high-conflict areas. Furthermore, the suite of mitigation efforts in place around protected areas needs to be tailored not only to the explicit nature of the conflict and the socioecological processes dictating this, but also to distal political ecology factors driving this. The costs associated with mitigating HWC, however, will continue to hinder development.

**R05 – Assess the potential of an insurance scheme to mitigate losses due to conflict**

This final objective sought to investigate the potential of a shared-fund insurance scheme to mitigate financial loss as a result of HWC, using VNP as a case study. Existing schemes in Rwanda generally and northern Rwanda specifically indicated that a locally-funded insurance pool, to cover damages resulting from HWC, may be feasible. Valuation exercises in this study did not allow premium levels of such a scheme to be calculated, though unusual bidding patterns suggested that insurance may be treated as a luxury good. The strong theoretical support for such a scheme shows that it may reduce or replace investment in more conventional mitigation. Comparison of this study’s findings to similar existing insurance schemes suggests that local collective funds against crop losses are a sustainable solution for this and similar conflicts. However, participation in such funds globally may be driven by both false presumptions of its efficacy and by perceived increases in social status upon participation.

**9.3 Final comment**

Global human population pressure and growing acknowledgement of the importance of conservation (either for the intrinsic-value of biodiversity, the potential for nature-based tourism revenue or commercial scientific value) have resulted in increasing resource constraints on the margins of protected areas. This is particularly acute in the developing world and where biodiversity with high tourism value remains. There is thus decreasing space for human development and conservation to remain physically separated. Complicating the debate between both these world views is the interaction between the fauna supported by protected areas and adjacent human populations, manifesting as HWC. To assess the impact of this HWC on conservation and development efforts, VNP in northern Rwanda has provided a useful example, as it exhibits the complex pressures affecting human-wildlife conflict, but is also subject to significant conservation and development challenges.
Crop raiding and its detrimental effect on the livelihoods of park-adjacent residents were clearly shown in this study. This is having a negative impact on support for conservation and is imposing significant livelihood limitations on a population already marginalised. Although those farming land adjacent to VNP are encouraged to adopt conservation, impetus to forgo use of this easily-accessible resource is limited, due to a lack of revenue sharing from the highly lucrative mountain gorilla tourism industry. Though investment in local infrastructure is a prominent feature of revenue sharing, this study has found that the majority of those most at risk of HWC are largely removed from these benefits. Thus, a combination of fortress conservation and an expectation of cooperation from park-adjacent communities is naïve. Rwandan resource governance and unstable international relations, however, mean that the required changes to represent these park-adjacent farmers, beyond simply ensuring cooperation with tourism goals, are unlikely.

In this case study, wider political drivers of HWC, such as international civil unrest, national agricultural export targets and agro-industry intervention, were found to be as important as proximal ecological determinants. As a result, this case study shows that lessening the effects of HWC on conservation and development necessitates a more holistic approach to conflict analysis and mitigation than previously adopted in HWC studies elsewhere. In addition to providing more robust solutions, broader approaches (such as that offered by political ecology) circumvent the necessity for the collection of detailed ecological data to characterise the proximal drivers of conflict, allowing solutions to be reached quicker.
10. References


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Appendices

Appendix A – Focus Group Schedule – 04/10/2011

1) Introduction
2) Ice Breakers – Village resource mapping
3) Exercise 1 – Farming system discussion
4) Exercise 2 – Pair-wise ranking of problems
5) Exercise 3 – Trend Lines of issues. Discuss relationships.
6) Analysis of problem – focussing on crop raiding.
7) Perception of the park – Responsibility, revenue sharing and relationship with RDB
8) Conclusion and wrap up. Gift giving

Facilitator Notes. Encourage participation from all present, making special reference to those who may remain quiet. Avoid domination by any one party. Allow talking amongst themselves, but continue recording what is taking place, who is saying what and the attitudes of those talking. Don’t be afraid to step back and allow them to debate. Don’t be afraid of small periods of silence. Be sure to steer topic of conversation at all times in the desired direction. We are there to find out about their attitudes to the national park and any problems they have with it. Other issues should be listened to but quickly move on from. Do not be afraid to stop and ask me questions in English if you are unsure of anything along the way.

Caution should be taken not to suggest answers to them in your description of the question. E.g. Do not say “What problems do you have? Like water and fertilizer shortage?” Instead just ask the question and let them think. Ask questions in a different way, but be aware of ‘planting’ answers. At each decision made be sure to ask the entire group whether they are in agreement. If you suspect there are some in the group who do not agree, carefully ask them why they do not agree, but do not single these people out or stigmatise their decision.

Outline that this will be recorded but that it will be completely anonymous. No full names will be used. This will not be passed on to the RDB, government, etc. As they can see, no local authorities are participating in this.
1) **Introduction.** Brief introduction to who we are, what we are hoping to do, who we work with and who we do not work with. Outline the structure of what we will be doing.

2) **Ice Breakers.** Village resource mapping. Not meant to be spatially accurate but is intended to gain full participation of everyone present and get ideas flowing.

3) **Exercise 1 - Farming system diagram.** Discuss where people plant things, why, when and who owns what. Ask questions about why certain crops are grown in certain places. Did someone tell them to grow these or did they decide themselves?

4) **Exercise 2 - Pair-wise ranking of issues.** Use sticky notes to list problems of living in the area, ensuring that not just one person lists these problems. Then hold them up and gain consensus on which is more important in each comparison. This should reveal a good picture of problems that are most important in the area. If crop raiding is not mentioned in this, it might be worth bringing up why they did not mention it.

5) **Exercise 3 - Trend Lines.** Using extensive description of the idea of a graph. If they do not understand this, simply ask them by year what the levels of each problem was. Ask the group which unit of time should be used. The amounts of yield. The numbers of crop raiding events they experienced. This is designed to investigate the change in problems over time. And if patterns in this become clear ask questions about why they think these patterns exist. It is very important that participants feel they are helping to solve the problem and are working together to find a solution.

6) **Analysis of problems - Problem analysis chart.** People will be asked about the most important problems they have outlined. First we ask about the causes they think are attached to these problems. Then they are asked how they deal with these problems now. Finally they are asked how they would deal with this in the future. So, causes, coping strategies and possible solutions. If crop raiding is not mentioned in this, it might be worth bringing up why they did not mention it. Do they see this as a problem or an environmental condition? Does the group consider it a problem that they can control themselves? Who is responsible for solving these issues? How are they currently
controlled, and who does this? What actions would you take if you had the resources to do this?

7) Perception of the park. Can you tell me a little about the people who conserve the park? Do you think they listen to your problems? What is more important, park conservation or local livelihoods? Do you think livelihoods are given the same priority as conservation? Why should the park be conserved and who should do this? Do you feel responsible for park conservation? Can you tell me a little about revenue sharing from the park? What do you know about it? What would you change about conservation of the park, if you had the choice and the ability?

If time allows begin casual discussion about local Batwa communities. Open with broad question such as; I am interested in the batwa of the area, can you tell me a little about them? Be very aware of cultural sensitivities here and legal restrictions surrounding “historically-marginalised people”.

8) Conclusion and wrap-up. Main decisions reached are read out again. Any final disagreements are questioned. If they have any questions for me allow them to be asked. People are given presents (plastic basin).

Final thank you and goodbye.
Appendix B – Administered Survey

B1: Administered Survey – English – 19/01/12

Introduction
Explanation of who we are, and that we are not working for the RDB, Government, DFGFI. We will not be paying you for your participation, though we may give you a gift. We will be using your knowledge for good to try and help problems in the future. Because of this, it is very important that you be completely honest. Please do not exaggerate problems, or lie in any way to us. This will not help you or us. If you do not want to participate that is fine, but please tell me. This will be recorded on tape; do you mind about this? If so, it is fine, I will write it down. The information you give will be completely anonymous: no names will be recorded and the information you give will not be traceable. This information will be used as part of my PhD research in Ireland. As part of this, it will be used to make recommendations to try and resolve this problem. If you do not agree with any of what I have said you are free to decline to participate.

A. Personal information

1. How many people are in your family?

2. What wealth category are you classified under?

3. How many children do you have?

4. How long have you lived here?

5. Observations on wealth status.
   • Construction of main dwelling
     - Mud brick
     - Wattle and daub
     - Volcanic stone
     - Wood plank

   • Hedge present around house – Y/N
   • Outside cooking house – Y/N
   • No. of permanent buildings
   • Cattle owned – Y/N
   • Flowers planted around house – Y/N
B. Agriculture and Land Tenure

1. Do you own your land or do you work on someone else’s land?
   a. If own land,
      i. How big is your land?
      ii. What crops do you grow?
      iii. Do you grow them together or apart?
   b. If collective land,
      i. How many people work this land?
      ii. How big is this land?
      iii. What is grown?

2. Do you choose what to grow on your land?
   a. If no,
      i. Who chooses?
      ii. Why, in your opinion do they tell you what to grow?
      iii. Do you agree with this?

3. Do you grow pyrethrum?
   a. If yes,
      i. How much of your land is taken up by this?
      ii. Who’s choice was this?
      iii. Is growing pyrethrum a good thing or a bad thing?
      iv. Do you gain money or lose money from growing this?
   b. If no, why not?

4. Do you sell your crops in the market?
   a. If yes,
      i. How do you get your crops to the market?
      ii. Which crops do you send to the market?
   b. If no, how do you obtain other food and items?

5. Do you intercrop on your farm?

6. Can you estimate the total value of all your crops?

7. Where do you collect water during the dry season?
   a. How far is this from your house?

8. Where do you collect water during the wet season?
   a. How far is this from your house?

C. Human-wildlife conflict

1. Do animals ever visit your land?
2. Where do these animals come from?

3. Which animals come?

4. Do they damage crops?
   a. If yes,
      i. Which crops are damaged/lost?
      ii. Can you estimate how much money you lose because of this every time it happens?

5. Do gorillas ever come onto your land?
   a. If yes, do they damage anything?

6. How often do these animals visit your land?
   a. In the last year, how many times has this occurred?
   b. In the last 10 years, how many times has this occurred?

7. In the past which animals came?

8. Is this the same today? What animals come nowadays if it is different?

9. When was the last visit?

10. Is anything done to stop this?
   a. If yes, what is done?
   b. If no, why not?

11. Do you guard your land?
   a. If yes,
      i. Who does this guarding?
      ii. How is this done?
      iii. How much time/money do you spend doing this?

12. Do you think you can do anything to solve this problem?
D. Conservation and responsibility

1. Why do you think animals come out of the park?

2. What does the park give you?

3. What do you give the park?

4. What does RDB do to protect the park and the people who live around it?

5. Are they doing enough?

6. What do you do to protect the park?
   a. Why do you do this?

7. Are you a member of any cooperatives?
   a. If yes, does this amatsinda receive revenue sharing from RDB?
   b. If no, why does it not receive RS?

8. How would you use revenue sharing from the park, if you could decide?

9. Who is responsible for protection of the forest?

10. Do you use the forest for anything in your day to day life?

11. Would you say the Batwa community are a good thing or bad thing for the forest?

E. Contingent Valuation

As you have highlighted in our discussion, crop raiding is a major issue for you. You have told us how people have lost much of their crops to these animals even though the wall is there and crop rangers patrol at night time. So you have a reduced amount of crop that you can sell in the market and that you can eat yourself. You have also told us that you need to guard your crops at night or pay for others to guard your crops at night.

I also now know that many people in your area already contribute to Mutuelle de Santé health insurance and others contribute to remittance schemes. Through these funds, you are given assistance money if something bad happens.
With this information you have given us, I would like to ask you a question. We are thinking of setting up an insurance fund to pay for the damage caused by wildlife to crops. Everyone in the area would pay a certain amount every month into a common fund, and this would then be used to compensate people in the area who lost crops through crop raiding. As you have told us that everyone is affected by this problem, you would be protecting yourself by paying into this. The size of this amount to be paid each month will be based on your risk to animals from the forest. This money would be given directly to a committee of local people nominated by those who pay into the scheme. Through this fund you would be covered for the amount of money you lost through either damage of mature crops (big potatoes in the ground ready to harvest, for example) or immature plants (small maize or wheat plants, for example). Measurements of the damage will be carried out very quickly after the damage has taken place, (quicker than this has been done before - I know at the moment this can take a very long time). It will be done as soon as you report it to your village leader. Measurement will be done by an independent assessor, who does not work for RDB, or the government or any NGO. This assessor will be very well trained and will have a very good idea of the amount of lost potatoes/beans/peas which could have been sent to the market, based on the number of plants lost, the age of the plants and the area damaged. This assessor will be nominated by the group and their payment, including transport fees, will come out of this fund. The level of this payment will be decided by the group. In this way, making false claims costs the group more money and means the amount each person pays per month goes up.

This measurement will then be used to distribute money from the fund you have paid into to the people whose crops have been damaged. This will all be done very quickly. Some months there will be less crop damage than others. There will be a reserve fund kept for when things are very bad; for when a lot of people lose crops. At the end of every year, if there was less damage than expected and there is money left over, in addition to this reserve fund, you will be given money back based on the amount you contributed during the year. Or, if your committee and its members agree, this excess money could be used to help strengthen the wall at the edge of the forest.

This fund will be regulated by the people who pay into it. If a person cheats on this and does not pay as much as he/she can afford the fund may not go ahead at all, as there will not be enough money to cover all the damage done. Also, if one person cheats by exaggerating the amount of damage done or faking some damage, the cost of paying into the fund would go up for everyone, including the person who is cheating.

If enough people agree to the idea of this fund now, this scheme could go ahead. At the moment we are investigating how this would work. You will not have to pay this money now - this is only an exercise- but please think of the next set of questions as though they were real decisions you had to make, and any money you gave you would not be able to spend on anything else.

In order for this fund to go ahead the total money collected in your village per month must reach xxx,xxx RwF. As we said before, if there is too much money in the fund you will get back a refund proportional to the amount you put in or, if you as a group wish, this could be used to strengthen the wall at the edge of the forest.
1. With all this in mind, would you be willing to pay xxxxRwF per month into this fund?  
   a. If yes, would you be willing to pay xxxx + yyyyRwF per month?  
   b. If no, would you be willing to pay xxxx – yyyyRwF per month?  

2. Would you still spend the amount of time or money protecting crops (guarding at night or building a wall etc...) if you paid into this insurance scheme?  

3. If you were obliged to contribute this amount of money, would you prefer that it went to the insurance fund or paid for stronger defences?  

F. Post hoc validation of Contingent Valuation  
(Following exercise on contingent valuation) Explanation that the exercise was designed to illicit a value of expected loss due to crop raiding.  

1. With this knowledge would you still give the same figure of xxxxRwF for the amount of loss you incur every month from raiding?  
   a. If not, would your estimate be more or less than this figure?  

2. What amount of money do you expect to lose because of animals from the forest in the next year?  

G. Risk Preference  
1. 100 francs for sure – or 50/50 chance of zero francs or 200  
   100 francs for sure – or 50/50 chance of zero francs or 300  
   100 francs for sure – or 50/50 chance of zero francs or 400  
   100 francs for sure – or 50/50 chance of zero francs or 500
INTRODUCTION

Muraho, twagirango mbere yokubbwira abo turibo tubanze tubashimire kuba mutwakiriye hano iyanyu. Ntabwo turi abakozi ba leta, RDB cyangwa se DFGFI. Amakuru muduha azifashishwa mu gushakira hamwe uburwo ibibazo mumhura nabyo byazabonerwa umuti mu gihe kizaza.


Amakuru muduha azaba ari amabanga hagati yacu, nta mazina yanyu twandika kandi ntabwo azigera atangwa ku batayagenewe. Aya makuru tuzayifashishwa mu burwo bwo kubona impamyabumenyi yo mu rwege rwa PhD muri Universite ya Trinity muri Ireland. Nanone azakoresha mu gutanga ibyifuzo ku nzego zo hejuru mu Rwanda kugirango habashe kuboneka ibisubizo by’ibi bibazo by’inyamaswa ziva muri pariki zije kubonera.

Mumaze kumva ibi mufite uburenganzira bwo kwemera kuganira natwe. Mumakoze.

A - AMAKURU KU GITI CY’UBAZWA

1. Mufite abantu bangahesa mu muryango wawe?
2. Umuryango wawe ubarirwa mu kihe cyiciro?
3. Ufite abana bangahesa?
4. Hashize igihe kingana iki utuye aha? Hashize igihe kingana iki uhinga hafi ya pariki?
5. Kwitegereza imiterere y’aho atuye
   - Uburwo inyubako ite ye
     o Yubakishijie nkarakara
     o Amatafari ahiye
     o Amabuye
     o Imbaho n’ibiti
   - Uruzitiro Yego/Oya
   - Afite igikoni hanze YEGO/ OYA
   - Umubare w’amazu afite
   - Amatungo YEGO/OYA
   - Ni ayahe matungo mufite mu rugo rwanyu?
   - Indabyo zihinze impande y’urugo
B - UBUHINZI N’IYANDIKWA RY’UBUTAKA

1. Ufite umurima ku giti cyawe cyangwa uwufatanije n’undi muntu? UHINGA mu kwawe cyangwa uhingira abandi?
   a. Niba afite ubutaka
      i. Umurima wawe ufite ubuso bungana iki?
      ii. Ni ibihe bihingwa uhinga mu murima wawe? Ukurikije ibihe by’ihinga uko bitandukanye.
      iii. Ese mubihinga muri rusange (murabivanga)?
   b. Niba ari umurima asangiye n’abandi
      i. Ni abantu banghae mufatanije uwo murima?
      ii. Uwo murima ungana iki?
      iii. Ni ibihe bihingwa muhinga muri uwo murima? Ukurikije ibihe by’ihinga uko bitandukanye.

2. Mwebwe ubwanyu muhitamo ibyo muhinga muri uwo murima?
   a. Niba ari Oya
      i. Ninde ubahitiramo ibyo ibyo muhinga?
      ii. Ese ubwanyu mutekereza ko yaba ari iyihe mpamvu babahitiramo ibyo muhinga?
      iii. Ese ibi murabyemera?

3. Muhinga ibireti?
   a. Niba ari Yego
      i. Ni ubutaka bungana iki babasaba guhingamo ibireti? Ese n’imirima ingahe babasaba guhingamo ibireti?
      ii. Ninde uhitamo ibi?
      iii. Ese guhinga ibireti mubona ari ikintu cyiza cyangwa kibi? Kubera iki?
      iv. Ese mutakaza amafaranga mu guhinga ibireti cyangwa mubona inyungu mu kubihinga?
   b. Niba ari Oya, ni ukubera iki?

4. Mugurisha imyaka yanyu mu isoko?
   a. Niba ari Yego
      i. Mukoresha iki kugirango mugeze imyaka yanyu ku isoko?
      ii. Ni ibihe bihingwa mujyana ku isoko?
   b. Niba nta bihingwa mujyana ku isoko, mubona gute ibindi biribwa cyangwa se ibindi mukenera gukoresha mu rugo rwanyu?

5. Mwaba muvanga ibihingwa mu murima wanyu?

6. Ushobora kugenekereza amafaranga ubona mu musaruro wawe?

7. Mu gihe cy’impeshyi muvoma he?
   a. Ni kure kungana iki uvuye mu rugo

8. Mu gihe cy’imvura muvoma he?
   a. Ni kure kungana iki uvuye mu rugo
C - AMAKIMBIRANE HAGATI Y'INYAMASWA N'ABATURAGE

1. Ese inyamaswa ziyja zigera mirima yanyu? Ese inyamaswa ziyja zigera mu myaka yanyu?

2. Izi nyamaswa ziba zivuye he?

3. Ni izihe nyamaswa zikunda kuza? Ni ryali zikunda kuza?

4. Ese zaba zangiza imyaka?
   a. Niba ari Yego
      i. Ni ibihe bihingwa byonwa cyane?

5. Ese ingagi ziyja zigera mu mirima yanyu?
   a. Niba ari Yego, hari icyo zangiriza?

6. Ni kangahe inyamaswa ziza mu mirima yanyu?
   a. Mu mwaka ushize, zaba zaraje kangahe ugereranyije?
   b. Mu myaka icumi ishize, zaba zaraje incuro zngahe ugereranyije?

7. Mu bihe byashize, ni izihe nyamaswa zakundaga kuza mu mirimayanyu?

8. Ese ni kimwe ubu? Niba atari kimwe ni izihe nyamaswa zikunda kuza?

9. Ziheruka kuza ryali?
   a. Ese Mushobora kugenekereza mukatubwira nk'amafaranga mutakaza igihe cyose zaboneye? Mwatubwira se aho zaboneye mwahombye amafaranga angahe mugereranyije?

10. Haba hari icyakozwe kugirango iki kibazo kibonerwe umuti? Ni iki mukora kugirango muhagarike iki kibazo?
    a. Niba ari Yego, ni iki cyakozwe?
    b. Niba ari Oya, ni ukubera iki?

11. Murinda imirima yanyu? Ese umurima wawe waba urindwa nawe cyangwa undi muntu?
    a. Niba ari Yego
       i. Ninde ukora uburinzi?
       ii. Abana bawe se baba barinda imyaka yawe?
       iii. Bukorwa bute?
       iv. Ese mutakaza igihe kingana iki cyangwa amafaranga angahe mu kwezi mukora uburinzi bw'imyaka yanyu?
    b. Niba se utarinda imyaka yawe, ni iyih e mpamvu?

12. Mutekereza ko hari icyo mwakora kugirango mukemure iki kibazo?

13. 100 francs for sure – or 50/50 chance of zero francs or 200
    100 francs for sure – or 50/50 chance of zero francs or 300
    100 francs for sure – or 50/50 chance of zero francs or 400
100 francs for sure – or 50/50 chance of zero francs or 500

**D - KURINDA IBIDUKIKIJE N’INSHINGANO**

1. Mutekereza ko yaba ari iyihe mpamvu inyamaswa zisohoka mu ishyamba zikaza kubonera imyaka yanyu?

2. Ni iki pariki ibaha

3. Ni iki mwebwe ubwanyu muha pariki?

4. Ni iki RDB ikora kugirango irinde pariki n’abaturage baturiye pariki?

5. Ese ibyo bari gukora birahagije(abayobozí ba RDB)?
   a. Niba ari Yego, mwatubwira uburyo mubibona?
   b. Niba bidahagije, mwatubwira impamvu mubona ko bidahagije?

6. Mukora iki kugirango murinde pariki?
   a. Kubera iki se mubikora

7. Hari koperative/amatsinda waba ubereye umunyamuryango?
   a. Niba ari Yego, koperative/amatsinda yanyu yaba agira icyo abona (nk’inkunga ) kivuye kuri pariki?
   b. Niba ari Oya, yaba ari iyihe mpamvu ituma mutagira icyo mubona kivuye kuri pariki?

8. Muramutse mufite ububasha bwo gufata ibyemezo mwakoresha mute inyungu ziva muri pariki?


10. Mwaba mukoresha pariki mu mibereho yanyu ya buri munsí?

11. Ese mutekereza ko guturira ishyamba kw’abahejeje rwinyuma n’amateka ai ikintu cyiza cyangwa kibi? Kubera iki mutekereza ko byaba ari byiza/bibi?

**E - CONTINGENT VALUATION**

Nk’uko wabidutangarije mubiganiro twagiranye namwe ubushize ,konera n’inyamanswa ziva muri pariki ni ikibazo kibakomereye cyane .Mwatubwiye rwose ko abaturage batakaza umusaruro kubera izi nyamanswa ,n’ubwo hari urukuta rwubatsw rwo kuzikumira ndetse hakaba hari n’abaziirinda ninjoro.

Bityo rero kubera izi nyamanswa ,umusaruro wanyu uragabanuka cyane kuburyo mutabona umusaruro uhagije mujyana mu isoko n’uwo musigarana mu ngo zanyu wo kubatunga.Nk’uko mwabitubwiye rero mu guhanganu n’iki kibazo murinde ubwanyu imyaka yanyu ninjoro cyangwa se mu gushyiraho abarinti ba ninjoro muhemb'a.
Tuzi neza kandi ko abantu benshi muri uyu mudugudu wanyu abantu benshi bitabiriye ubwisungane bw’ubuzima (mutuelle)Abandi nabo bagiye baba mu bimina bimwe na bimwe. Ubu bwisungane rero bubatabara iyo mwageze mu ngorane (iz’uburwayi/ndetse n’iz’amafaranga)

Dukurikije amakuru mwaduhaye ,twifuje kubagezaho igitekerezo giteye gitya :turimo gutekereza uburyo habaho ubwisungane ku bwone bw’ibinyamanswa zivuye muri pariki ashobora kugira umubare w’amafaranga remeka.

Ariko uyu musanzu ugtatangwa mu buryo rusange bityo uyu musanzu wazajya ufasha mu kuriha ubwone bwatewe n’inyamanswa zo muri pariki.Dukurikije amakuru mwaduhaye ,buri wese muri mwe ahura n’iki kibazo cyo konerwa;mu gutanga uyu musanzu rero mwaba mwiteganyirije ubwanyu mu kuriha igihe mwonewe.

Ingano y’amafaranga yatangwa buri kwezi izajya ishingira ku ngaruka zaterwa n’inyamanswa za je kon a. Aya mafaranga yazahabwa komite izatorwa mu banyamurungo (umusanzu)uzabafasha kandi kuba mwakwisyurwa amafaranga mwabura ku musaruro wari uteganyijwe ku myaka izaba yonwe ari mikuru cyangwa se ku myaka ikiri mitoya hazakurikizwa kandi n’ingano mu buso bw’ahazaba hangirijwe n’inyamanswa. (urugero:ibigori, ingano, amashaza bikiri bitoya).

Gupima ingano y’ubwone ndetse n’ibyangirijwe,bizajya bikorwa ako kanya .Nyuma y’uko ubwone buba.(bigomba gutanga ako kanya kurusha uko byakorwaga mbere.kuko tuzi ko mbere byashobora gufata igihe kirekire)Bizajya bikorwa n’umuntu utagira aho abogamiye ,udakorera RDBcyangwa se leta cyangwa se undi muryamungo utegamiye kuri leta . Uyu mugenzuzi azaba ari umuntu whuguwwe mu buryo bwimbitse kandi azaba afite ubumenyi buhagije bwo kuba yamena ingano y’ibyangiritse: ibirayi,ibishyimbo,amashyaza kandi n’agaciro byagira ku isoko,akurikije umubare w’ibyangiritse, igihe byari bimaze mu murima n’ingano mu buso’ahangirijwe. Uyu mugenzuzi kandi azashyirwaho n’abanyamurungo. Amafaranga azajya ahembwa, ay’ingendo, azajya ava mumusanzu w’abanyamurungo. Gutanga amakuru atari yo cyangwa y’impimbano bizatwara abanyamurungo amafaranga menshi kandi bizatuma umusanzu wiyongera kuri buri munyamurungo

Iri pima kandi rizakoreshwa kugirango rifashe kuriha mu buryo bw’ukururi ubwone bw’umunyamurungo.Libi bizajya bikorwa mu gihe gito cyane. Nanone hari ubwo hazabaho amezi azagaragaramo ibikorwa biri hasi by’ubwone kurusha ayandi. Hazabaho amafaranga agomba kuzigamwa yo kugoboka mubihe bibi,nk’igihe abantu benshi bazaba bonewe.

Haramutse hagaziza ko habaye ubwone bukeya ku bwari buteganyijwe ku mwaka, Ariko nanone kandi aya mafaranga azaba yazigamwe, azajya agabanwa n’abanyamurungo hakurikijw ayo buri munyamurungo yatanze ku mwaka.

Nanone ariko,komite n’abanyamurungo babyumvukanyeho, bashobora gukoresha aya mafaranga mu gusana urukuta kuri pariki kugirango rururusho gukomera.

Uyu musanzu uzajya ucungwa n’abanyamurungo umuntu wese uzashaka kubeshya mu gutanga umusanzu ufite ubushobozi abeshya ko ntabo afite )azaba atambamire iki gikorwa kandi azatuma kitagerwaho na rimwe.Musabwe rero gukoresha ukuri kuko murengera inyungu simwe riko ku rugero rutandukanye(umukire /umukungu/umukene).
Nanone haramutse habayeho gutanga amakuru atariyo, ku ngano y’ubwone, kungano y’ibyangirijvye guha agaciro katari ko ku byangirijwe, ibi bizatuma umusanzu wiyongera kuri buri muntu ndetse no ku watanze amakuru Atari yo.

Nihaboneka umubare ugaragara w’abashyigikira iki gikorwa, Iki gikorwa kigomba gutangira. Muri iki gihe turimo kwiga uburyo ibi bizashyirwa mu bikorwa

Ntabwo muzahita mwishyura aya mafaranga ubu, gusa tubahaye umuhigo mukwiye kwesa. Ariko hari ikind gice cy’ibibazo tuzakenera kuganiraho namwe bizatuma mu bisubizo muzaduha, muboneraho umwanya wo gufata imyanzuro kandi umusanzu muzatanga, nta kindi kintu uzakoreshawmo kindi.

Kugirango iki gikorwa kigerweho umusanzu uzatangwa n’umudugudu wayo ku kwezi ugomba kugera ku mafaranga xxxxxxx. Nk’uko twabivuze mbere, nihagira amafaranga asaguka umwaka urangije muzayagabana hakurikijwe ayo umuntu yatanze cyangwa se abanyamuryango mubishatse mwaakoresha aya mafaranga musana urukuta kuri pariki.

1. Umaze gusobanukirwa n’iki gikorwa, wumva ushobora gutanga amafaranga __________ ku kwezi?
   a. Niba ari yego, wumva watanga frw __________ ku kwezi?
   b. Niba ari oya, wumva watanga frw __________ ku kwezi?

2. Ese murumva muzakomeza kurinda imyaka yanyu burigihe cyangwa gutanga amafaranga yo kuyirinda(kuyirinda ninjoro cyangwa se gusana uruzitiro ....) mutanga umusanzu wayo muri ubu bwishingane? Niba utazakomeza gutakaza igihe cyawe /amafaranga urinda imyaka yawe, urabona bizahinduka gute?

3. Ese muramutse musabwe gutanga uyu musanzu buri kwezi, mwahitamo kuwutanga mwishingana ku bwone cyangwa mwahitamo gutanga uyu musanzu mu fasha kwubaka urukuta rukomeye?

F - POST HOC VALIDATION OF CONTINGENT VALUATION

1. Ibi bisobanuro tubahaye byo kwishingana ku bwone twagirango mubashe gusobanukirwa no kuba mugereranyije mwatanga umubare w’amafaranga mutakaza buri kwezi igihe mwonewe. None rero mumaze gusobanukirwa neza, ese mukurikije amafaranga mutakaza buri kwezi kubera konerwa, murumva mwaakoresha gutanga umusanzu ungana n’uwo mwemera gutanga ubu ku bwishingane bw’ubwone?
   a. Niba ari Oya , ushobora kugereranya ukatubwira ayo utajya hasi cyangwa hejuru?

2. None se amafaranga mutekereza gutakaza kubera inyamaswa zibonera zivuye mu ishyamba yazaba angina iki (mugereranije) umwaka utaha?
A - Household Data

Age: _____ Gender: _____
1. _____ 2. _____
3. _____ 4. _____
5. a. Mud Brick □
b. Wattle and Daub □
c. Volcanic Stone □
d. Wood plank □
e. Floor - Solid/Dirt
g. Hedge present - Y/N
h. Outside cooker - Y/N
i. Livestock - Y/N
j. Flowers planted - Y/N

B - Agriculture and Land Tenure

1. __________
a. i) _______ ii) _______ iii) _______
b. i) _______ ii) _______ iii) _______
2. Y/N a. i) _______ ii) _______ iii) _______ Y/N
3. Y/N a. i) _______ ii) _______ iii) _______ Good/bad
   iv) Gain/Lose _______ b. _______
4. Y/N a. i) _______ ii) _______ Y/N
   b. _______
5. Y/N 6. _____
7. _______ a. _____
8. _______ a. _____
9. _______ b. _____
10. Y/N a. _____
    b. _____
11. Y/N a. i) _______ ii) Y/N
    iii) _______ iv) _______
    b. _______
12. _____

C - Human-wildlife Conflict

1. Y/N 2. _____
3. Animal _____ Season
   Animal _____ Season
   Animal _____ Season
4. Y/N a. i) _______
5. Y/N a. _______
6. _______ a. _______
   b. _______
7. _______ 8. Y/N a. _______
9. _______ a. _______
10. Y/N a. _______
    b. _______
11. Y/N a. i) _______ ii) Y/N
    iii) _______ iv) _______
    b. _______
12. _____

D - Conservation and Responsibility

1. _______
2. _______
3. _______
4. _______
5. Y/N a. _______ b. _______
6. _______ a. _______
7. Y/N a. Y/N b. _______
8. _______
9.

a)

10.

11. Good/Bad a) 

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## Appendix C - Monitoring Data Collection Sheets

### Volcanoes National Park Human-wildlife Conflict Monitoring Sheet - A

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<th>Age of crop</th>
<th>Damage done</th>
<th>Nearest house</th>
<th>Animal + No.</th>
<th>Day/Night</th>
<th>Exit Lat./Long.</th>
<th>Entry Lat./Long.</th>
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**Comments:**

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Received by: ____________________________  Submitted by: ____________________________  Date: ____________________________
**Volcanoes National Park Human-wildlife Conflict Monitoring Sheet - B**

Umurenge: ___________________  Akagari: ___________________  Collector: ___________________

**Other damages: Human being, properties (Eg: house, infrastructures ...)**

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Appendix D – Boundary Survey Data Collection Sheets

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Digital Appendix

B – VNP 3-D Flythrough
C – Focus Group Transcripts
D – Coded Administered Survey Data
E – Boundary Survey Data
F – Monitoring Data