HONEYGUIDES, HONEY-HUNTING, AND THE CURRENT STATE OF HUMAN-HONEYGUIDE MUTUALISM IN NORTHERN MALAWI

MSc. (FORESTRY AND ENVIRONMENTAL MANAGEMENT)

THESIS

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MZUZU UNIVERSITY

APRIL, 2024

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A THESIS SUBMITTED TO THE FACULTY OF ENVIRONMENTAL SCIENCES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN FORESTRY AND ENVIRONMENTAL MANAGEMENT

MZUZU UNIVERSITY

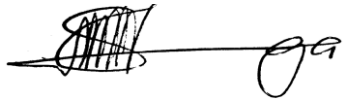
APRIL, 2024

DECLARATION

I hereby declare that this thesis titled, "Honeyguides, honey-hunting and the current state of human-honeyguide mutualism in northern Malawi", is written by me and is a record of my research work. All citations, references, and borrowed ideas have been duly acknowledged. It is being submitted in fulfilment of the requirements for the award of the degree of Forestry and Environmental Management of Mzuzu University. None of the present work has been submitted previously for any degree or examination in any other University.

Parts of the materials presented in this thesis have been submitted for publication or have been published and appear as:

van der Wal, J.E.M., Afan, A.I., Anyawire, M., Begg, C.M., Begg, K.S., Dabo, G.A., Gedi, I.I., Harris, J.A., Isack, H.A., Ibrahim, J.I., Jamie, G.A., Kamboe, W.-B.W., Kilawi, A.O., Kingston, A., Laltaika, E.A., Lloyd-Jones, D.J., M'manga, G.M., Muhammad, N.Z., Ngcamphalala, C.A., Nhlabatsi, S.O., Oleleteyo, T.T., Sanda, M., Tsamkxao, L., Wood, B.M., Spottiswoode, C.N. & Cram, D.L. (2023). Do honey badgers and greater honeyguide birds cooperate to access bees' nests? Ecological evidence and honey-hunter accounts. *Journal of Zoology*. DOI: 10.1111/jzo.13093



George Malembo M'manga — 10 April 2024

Student's name — Date

CERTIFICATE OF APPROVAL

I, the undersigned, certify that this thesis is a result of the author's work and that to the best of my knowledge, it has not been submitted for any other academic qualification within Mzuzu University or elsewhere. The thesis is acceptable in form and content, and that satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate through an oral examination held on 1st December, 2023.

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ABSTRACT

Human-wildlife conflict has received considerable attention from scientists worldwide. Positive human-wildlife interactions, however, are much less studied, despite their potential to better our understanding the value of coexistence. In particular rare forms of human-wildlife cooperation provide powerful examples of successful human-wildlife coexistence. In sub-Saharan Africa, people work together with Greater Honeyguides *Indicator indicator* to find and open wild bees' nests. Few places remain in which humans rely on wild honey and honeyguides to find it. To date, no scientific studies have been conducted on honey-hunting cultures with honeyguides in Malawi. This study investigated honey-hunting with honeyguides in northern Malawi by (i) characterising honey-hunting practices with honeyguides; (ii) describing functional components of human-honeyguide mutualism; and (iii) identifying possible threats and causes of its decline. To do so, 126 people were interviewed living in the vicinity of Vwaza Marsh Wildlife Reserve and Nyika National Park. The study shows that honey-hunting with honeyguides is still active in northern Malawi, and wild honey was found to be highly valued for food, income, and medicine. Honey-hunters use whistles and blowing instruments to communicate with honeyguides. Honeyguides are rewarded with wax combs filled with larvae, which is believed to motivate further guiding. Respondents reported a decline in honey-hunting due to three main factors: (1) fewer honeybees and honeyguides in forests, reportedly caused by deforestation; (2) increased popularity of beekeeping; (3) decreased interest among the youth. This study suggests that honey-hunting with honeyguides is in decline, but will likely continue to exist in northern Malawi. Further areas of research to be pursued include investigating other honey-hunting cultures in Malawi and evaluating the social and economic value of wild honey here.

DEDICATION

This thesis is dedicated to my late mother Harriet Ndaona Makanjira and supervisor Dr Tiwonge Mzumara-Gawa for their unconditional love and support.

ACKNOWLEDGEMENTS

Many thanks to God for sending me wonderful people who have been everything during this study. First, thanks to Dr Tiwonge Mzumara-Gawa for coming to my rescue when I was almost about to drop out of school due to fee challenges. Second, all my supervisors, Dr Jessica van der Wal, Assoc. Prof. Lusayo Mwabumba, and Dr Tiwonge Mzumara-Gawa, for guidance through the study, and for helping me secure funding for my fieldwork. Thanks to my supervisors' support and encouragement, I was able to take part in the International Ornithological Congress, the Pan African Ornithological Congress, Interspecies Cooperation Workshop, the world mountains day commemoration, and be a guest speaker at the Malawi University of Science and Technology (MUST) and Wildlife and Environmental Society of Malawi (WESM) in Blantyre. Thank you to members of staff from the Forestry and Environmental Management Department at Mzuzu University, the FitzPatrick Institute of African Ornithology at the University of Cape Town (UCT), and the Malawi University of Science and Technology (MUST) for their academic and moral support. Thank you to Dr Twalibu Tandwe and WESM members for their technical assistance. I would like to thank Peter Mtumbuka for accompanying me during field data collection. Thank you to the Nyika-Vwaza Trust (NVT) and Society for Conservation Biology for funding this research. Finally, I am very grateful to my family and friends for their moral and spiritual support in the success of the study.

ACRONYMS

a.s.l.	Above sea level
B.C.	Before Christ
BAM	Beekeepers Association of Malawi
DNPW	Department of National Parks and Wildlife
DoF	Department of Forestry
GLMM	General Linear Mixed Model
GoM	Government of Malawi
GTZ	German Agency for Technical Cooperation
MGBDP	Malawi German Beekeeping Development Project
MUST	Malawi University of Science and Technology
MWK	Malawian Kwacha
MZUNI	Mzuzu University
NP	National Park
UCT	University of Cape Town
USD	United States Dollar
WR	Wildlife Reserve

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CHAPTER 1: INTRODUCTION

In this chapter, the study's context is established, beginning with an overview of the tradition of honey-hunting with honeyguides. The subsequent section describes the research gap in honey-hunting with honeyguides in northern Malawi, and then outlines the objectives and research questions examined in the present study in northern Malawi. The final section of this chapter describes the significance of this study.

1.1 Background of the study

The issue of human-wildlife conflict has gained significant recognition and attention within the global communities of biologists and conservationists (Dickman, 2010; Merkebu & Yazezew, 2021). The task of conservationists who focus on mitigating human-wildlife conflict is challenging, as they must strive to achieve a balance between human needs and wildlife (Dickman, 2010). Even when human and wildlife interests align, this does not ensure straightforward conservation action (van der Wal *et al.*, 2022a). Despite the large number of research studies that have been conducted on negative interactions between humans and wildlife, there is a shortage of literature regarding the exploration of positive interactions between humans and wild animals in their natural environment (Benka, 2022; Cram *et al.*, 2022).

Few examples exist of human-wildlife cooperation, in which humans and wild, free-living animals coordinate their behaviour to achieve a mutually beneficial goal (Cram *et al.*, 2022). This is different from cooperation between humans and domesticated or captive animals, in which the animals are trained, e.g. to help humans find food, such as dogs, falcons, or cormorants (Dounias, 2018). Human-honeyguide and human-dolphin cooperation are the remaining active forms of human-wildlife cooperation known to the

scientific community, which are facing various ecological and cultural threats (reviewed in: van der Wal *et al.*, 2022a).

In parts of sub-Saharan Africa, Greater Honeyguides *Indicator indicator* (hereafter 'honeyguides') are wax-eating birds that guide humans to bees (primarily honeybees *Apis mellifera* [Isack & Reyer, 1989], and sometimes meliponine stingless bees [Spottiswoode *et al.*, 2016; Kilawi, 2023]), after which humans gain honey and honeyguides consume the left-over beeswax (Isack & Reyer, 1989). Honeyguides know where bees' nests are located, whereas humans know how to open the nests using tools and fire (Spottiswoode *et al.*, 2016). This remarkable human-bird cooperation has been prevalent throughout sub-Saharan Africa for possibly millions of years, but is currently known still to occur regularly in only a few places (van der Wal *et al.*, 2022a). Reasons for a decline in honey-hunting with honeyguides are many and context-dependent. First, increased availability of sugar can form an alternative to honey (Isack, 1999; Gruber, 2018). Second, the gaining popularity of beekeeping is replacing honey-hunting in some places, depending on the local socio-cultural conditions such as market demand and the perceived value of wild honey (Laltaika, 2021; Kilawi, 2023). Third, in some places "fortress conservation" practises have displaced indigenous peoples from their original homelands (Kabra, 2014), isolating honeyguides from humans, resulting in the local disappearance of cooperation between humans and honeyguides (van der Wal *et al.*, 2022a). Fourth, ecological change, likely accelerated by human cultural change, might be decreasing bee and honeyguide populations due to for example deforestation, and overharvesting (Isack, 1999). Fifth, threats to the security of others on honey-hunting grounds have reduced cooperation between humans and honeyguides in some places (van der Wal *et al.*, 2022b). Finally,

there is a general disinterest by youth in some places to acquire and pass on honey-hunting skills (Isack, 1999; Laltaika, 2021; van der Wal *et al.*, 2022a, 2022b), and without anyone to transfer the know-how on how to cooperate with honeyguides, the knowledge dies with elderly humans (van der Wal *et al.*, 2022a).

Humans still honey-hunt regularly with the help of honeyguides in a few areas in sub-Saharan Africa, for example among the Yao in Mozambique (Spottiswoode *et al.*, 2016), Hadzabe in northern Tanzania (Wood *et al.*, 2014), Maasai in northern Tanzania (Laltaika, 2021), Ndorobo in northern Tanzania (Laltaika, 2021), mixed-cultural groups in southern Tanzania (Kilawi, 2023), and Awer in Kenya (van der Wal *et al.*, 2022b). In those areas where people still often honey-hunt with honeyguides, there is cultural variation within and between cultures regarding human behaviour related to honeyguides. First, humans differ in the sounds and calls used to communicate with honeyguides (van der Wal *et al.*, 2022b). These range from general sounds like shouting or banging tools against trees, to specific sounds like trills and grunts, words, melodies, and whistling or blowing instruments (e.g., Isack, 1999; van der Wal *et al.*, 2022b). Although honey-hunters learn these sounds mostly from the elders, honeyguides don't learn from their parents. This is because honeyguides are brood parasites, raised by other bird species, so they cannot rely on social information from their parents (Spottiswoode & Koorevaar, 2012). However, honeyguides respond to local human signaling variations, indicating that they are learning in another way (Spottiswoode & Wood, 2023). Second, cultures vary in whether or not they actively reward the honeyguide after leading humans to bees' nests (van der Wal *et al.*, 2022a). People that share the contents of bees' nests (mostly empty wax combs or wax combs filled with brood) with the bird do this to thank the bird and

inspire the bird to lead them or other people in future (Spottiswoode *et al.*, 2016; Laltaika, 2021). On the other hand, Hadzabe and Awer people in in northern Tanzania and Kenya respectively, believe that the birds need to be kept hungry to motivate further guiding (Wood *et al.*, 2014; van der Wal *et al.*, 2022b). Nevertheless, the mutualistic relationship between honeyguides and humans can continue without actively rewarding the bird, since even if the human attempts to withhold the reward, the honeyguide can still reap benefits from small remnants of wax (Wood *et al.*, 2014; van der Wal *et al.*, 2022b).

In Malawi, honey has been sourced from wild bee colonies and traditional beekeeping for centuries (Munthali, 2007; Kaitano, 2013; Van Blyderveen, 2022). Despite gained popularity of the modern beekeeping industry in Malawi, people still practise traditional beekeeping (Van Blyderveen, 2022). Local people build beehives from materials such as wood, bark, grass, and clay and hang them from trees to trap the bees (Illgner *et al.*, 1998; Munthali, 2007; Van Blyderveen, 2022). Honey is consumed at home, exchanged for food, or sold for money (Munthali, 2007; Kaitano, 2013). In northern Malawi in the 1970s, many people had to abandon their traditional homes, the wild bees' nests they used to harvest, and traditional beehives they built during the expansion of Nyika National Park (Kaiser, 1994, Kaitano, 2013). Traditional beekeeping has been banned in some protected areas due to harmful harvesting practises (Kaitano, 2013). The honey industry has also suffered from product loss and deforestation due to poor harvesting techniques (Munthali, 2007; Kaitano, 2013; Van Blyderveen, 2022).

Alongside traditional methods of beekeeping, the collection of wild honey is also thought to still occur (Illgner *et al.*, 1998; Kaitano, 2013). It seems likely that honey-hunting

practises around Nyika National Park and Vwaza Marsh Wildlife Reserve vary within and between cultures, occupations, and locations. Although the term “Phokas” is often used to refer to the former residents of Nyika National Park, it should be noted that the Ngonde, Ngoni, Tumbuka, and other cultural groups that inhabit the region have diverse origins, which could account for differences in honey-hunting practises and approaches.

1.2 Problem statement

The culture of honey-hunting with honeyguides is disappearing or has already disappeared in several places in sub-Saharan Africa (Isack, 1999; van der Wal *et al.*, 2022a). For the communities involved, loss of honey-hunting knowledge means losing part of their cultural identities (Marlowe *et al.*, 2014; Wood *et al.*, 2014). For honeyguides, beeswax is an important part of their diet that they can rarely access on their own (Isack, 1999). The mutualism’s loss will also have wider impacts on local ecosystems, e.g. other wax-eating animals that benefit from harvested bees’ nests will lose their food (Lloyd-Jones, *et al*., 2022). Opportunities to study this unique mutualism in its full diversity are rapidly declining. Although studies on some honey-hunting culture with honeyguides have been carried out in Mozambique, Tanzania and Kenya, detailed studies of honey-hunting on other existing African honey-hunting cultures are lacking. In Malawi, no scientific studies of honey-hunting with honeyguides have been done, while it is anecdotally known to occur. Yet, the knowledge may help maintain and/or create a sustainable environment crucial for the success of mutualistic relationships within forest ecosystems. Effective forest management relies on a deep understanding of the forest's composition and the various activities related to it. Consequently, the main objective of this study was to document the techniques used for honey-hunting in northern Malawi.

1.3 Study objectives

The overall aim of this study was to investigate honey-hunting and the current state of human-honeyguide mutualism in and around Nyika National Park and Vwaza Marsh Wildlife Reserve.

1.4 Specific objectives

The specific objectives of the study are as follows:

1. To characterise honey-hunting with honeyguides;
2. To describe functional components of human-honeyguide mutualism;
3. To identify the threats and causes of the decline of human-honeyguide mutualism.

1.5 Research questions

The study is not explicitly hypothesis-driven, but the findings will contribute to the Honeyguide Research Project's broader research testing a hypothesis of cultural coevolution between humans and honeyguides in a geographical mosaic across Africa. The Honeyguide Research Project (www.AfricanHoneyguides.com) is leading a pan-African collaborative effort to document the remaining distribution and diversity of endangered honey-hunting culture with honeyguide birds that shape human-bird coevolution, which this research is part of.

The following research questions were used to assess the specific objectives:

Objective 1: To characterise honey-hunting with honeyguides

i. How is honey used among cultural groups?
ii. Do people rely on honeyguides to find honeybees' nests, and if so, how?

iii. Does the honeyguide lead humans to other things other than honeybees?

iv. How is honey-hunting learned?

Objective 2: To describe functional components of human-honeyguide mutualism

i. How do honey-hunters communicate with the honeyguides?

ii. What are the harvesting techniques used to harvest wild bees?

iii. What is the reward system used?

Objective 3: To identify the threats / causes of decline in human-honeyguide mutualism

i. What are the changes in honey-hunting identified over time?

ii. Has the role of the honeyguide changed or not?

iii. What is the people's perception of the future of human-honeyguide mutualism?

iv. Does efficient knowledge transmission occur from older individuals to younger generations?

1.6 Justification of the study

Human-wildlife cooperation is a rare form of mutualism between people and free-living wild animals, which has attracted recent attention of the scientific community since it is a unique form of positive relationship contrasting human-wildlife conflict, while it is being threatened to join extinct forms of human-wildlife cooperation (Cram et al., 2022; van der Wal et al., 2022a). Currently, the scientific community and conservationists have very little idea on the spatial scale over which humans cooperate with honeyguides. This study provides a reference to the scientific community regarding the status of human-honeyguide mutualism in Malawi, a country where honey is of important economic and cultural value, and where deforestation is a big problem. It gives the scientific community an improved understanding of the dynamic nature of mutualisms, which are key drivers of forest management, biodiversity, and ecosystem function. The study is a platform to inform decision-makers, the scientific community, and forest and park managers on the role of conserving biodiversity and cultures, by providing an example of a positive relationship between people and wildlife. The study contributes to an improved understanding of human-wildlife relations and highlights the importance of a positive human-wildlife interaction in peoples' livelihood and culture and community-based natural resources management. Beyond academic impact, this can empower honey-hunting communities, enabling them to share recommendations and showcase their cultural heritage for future generations.

CHAPTER 2: LITERATURE REVIEW

This chapter first explores the different forms of cooperative relationships between humans and wild animals. In the second section, human-honeyguide cooperation is discussed in more detail, discussing the different methods used to collect honey, seek the help of honeyguides, and the need to compensate birds for their help. The third section examines the potential measures to safeguard human-wildlife cooperation. The fourth and fifth sections explains the history of beekeeping in Africa more generally, and Malawi more specifically.

2.1 Human-wildlife cooperation

Mutualism describes the ecological interaction between two or more species where each species has a net benefit (Bronstein, 2015). Human-wildlife cooperation is a form of mutualism between humans and wild free living animals, whereby both parties engage in cooperative activities for mutual gain (Cram *et al.*, 2022). Throughout history, there have only been a limited number of documented instances of people and wild animals cooperating (Figure 1). Extinct partnerships once existed between human whale hunters and Orcas *Orcinus orca*, and likely between hunters and wolves *Canis lupus* (van der Wal *et al.*, 2022a). There are at least two forms of active human-wildlife cooperation that scientists know about (van der Wal *et al.*, 2022a): people in parts of Africa work with honeyguides to access wild bees' nests, and people in parts of South America and Asia work with at least two species of dolphins to catch fish. Cram *et al.* (2022) and van der Wal *et al.* (2022a) synthesised the existing knowledge of human-wildlife cooperation, and provided a framework on how these interactions benefit both communities and the ecosystem. van der Wal *et al.* (2022a) suggest ways to maintain the remaining active

forms of human-wildlife cooperation. Extensive research is required in locations where humans cooperate with wild animals to appropriately implement safeguarding measures.

2.1.1 Human-dolphin cooperation

In certain fishing spots in southern Brazil and Myanmar, fishermen work together with wild dolphins (Lahille's bottlenose dolphin *Tursiops truncates gephyreus* and Irrawaddy dolphins *Orcaella brevirostristo*, respectively) to catch fish (Simões-Lopes, 1991; Tun, 2004; Cantor *et al.*, 2023). Fishermen benefit from dolphins, as they help catch more fish, by bringing the fish closer to the surface or the shore (Simões-Lopes, 199; Smith *et al.*, 2009; Cantor, *et al.*, 2018). Fishermen wait for signals from dolphins before putting their nets in the water. The dolphins may also give signals to the fishermen about where and when the fish are present (Tun, 2005). In Myanmar, fishermen try to attract dolphins using sounds by tapping their vessels or slapping the water surface with their pedals (Tun, 2014). The dolphins benefit from feeding from the fish schools disrupted by the nets (Neil, 2002; Tun, 2014; Valle-Pereira *et al.*, 2022).

2.1.2 Human-orca cooperation

There are historical records of humans cooperating with orcas *Orcinus orca* in Russia and Australia from 1830 (Bogoslovskaya *et al.*, 2007). Orcas, also known as killer whales, are the largest member of the oceanic dolphin family (Clode, 2002). Orcas can be found worldwide in different ocean environments, and are top predators with a varied diet, this includes fish, sharks, rays, and marine mammals like seals (Clode, 2002). Orcas were described to team up with human-whale hunters and move the whales and other sea mammals towards the shallow waters or land. People benefitted from easier access to

their prey by the orcas' cornering, and then shared the catch with the orcas (Bogoslovskaya *et al.*, 2007; Neil, 2002). Human-orca cooperation is believed to have become inactive around 1926 in Twofold Bay in Australia (Clode, 2002).

2.1.3 Human-wolf cooperation

It is believed that North American indigenous peoples and wolves *Canis lupus* worked together in the past to hunt large ungulates (Pierotti & Fogg, 2017). It is suggested that wolves were more skilled in tracking and pursuing their prey, while humans were able to efficiently kill the weakened animal using spears. The humans on the hunt set aside a portion of the meat intended for the wolves (Fogg *et al.*, 2015; Pierotti & Fogg, 2017).

2.1.4 Human-honeyguide cooperation

Greater honeyguide birds have exhibited cooperative behaviour with humans across various regions of Africa to obtain the contents of bees' nests (Isack & Reyer, 1989). The birds function as guides for human beings towards the concealed locations of bees' nests (Isack, 1987). Once located, the bees' nests are harvested through specialised tools (often axes) and use of smoke, to collect honey and sometimes brood (Isack & Reyer, 1989). The remnant beeswax is then consumed by the birds (Isack & Reyer, 1989). The cooperative relationship between humans and birds observed in honey-hunting is hypothesised to have a potentially ancient origin (Wrangham, 2012). This is supported by the fact that both honeybees and the honeyguide lineage coexisted in Africa during the early stages of Homo's control of fire and smoke (Wrangham, 2012). Wood *et al.* (2014) point out that our closest relatives like chimpanzees, bonobos, and gorillas have been eating honey for a very long time. In areas where wild honey holds considerable

significance, there exist varied traditions among the local communities about the use of honeyguides to locate bees' nests (Laltaika, 2021; van der Wal *et al.*, 2022a; 2022b).

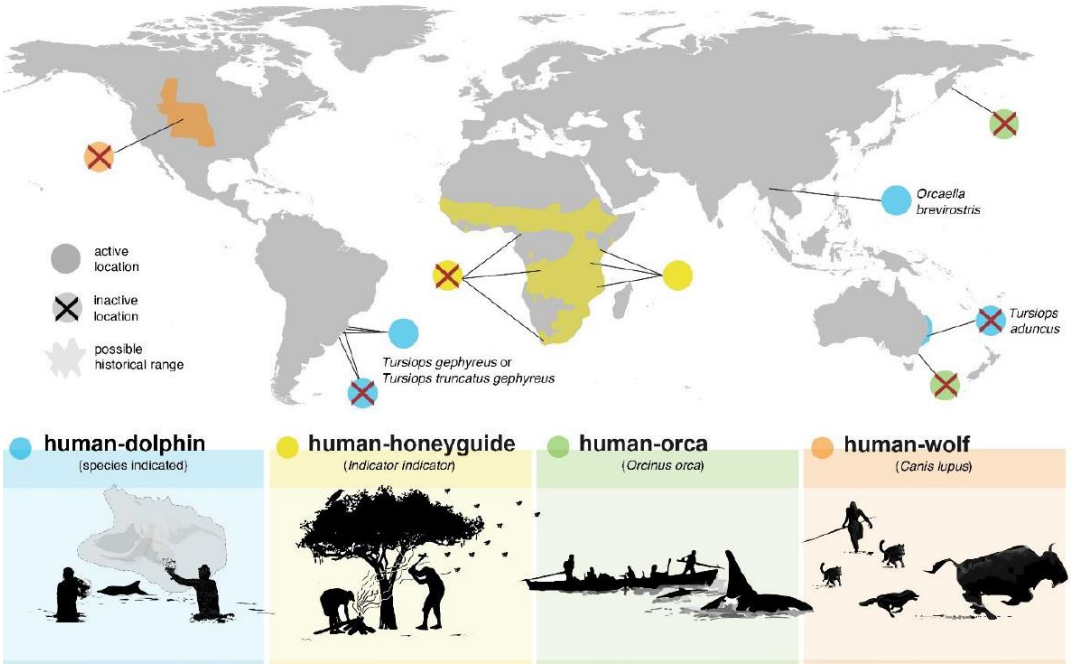


Figure 1: Active and inactive forms of human-wildlife cooperation across the globe, from: van der Wal., *et al.* (2022a). Used with permission.

2.2 Human-honeyguide cooperation in sub-Saharan Africa

2.2.1 Honeyguides' guiding behaviour

Friedmann (1955) suggested using the word "guiding" to describe the behaviour of honeyguides towards humans is wrong because the bird doesn't have a plan. He believed that the birds don't exactly know where bees' nest are and that it just happens to find bees' nests by chance. Isack & Reyer (1989) disagreed with Friedmann's evaluation after studying the interaction between honeyguides and Boran honey-hunters in Kenya. The scientists observed and tested the birds and found out that they often take the shortest path

to get from where they found the bird to the bees' nest. This was the first evidence that showed that honeyguides know where the bees' nests are before they start flying toward them. Several studies since then (Wood *et al*., 2014; Spottiswoode *et al*., 2016; Laltaika, 2021) have documented successful honey-hunting trips using honeyguides, which add to the findings of Isack and Reyer's (1989) empirical investigation.

There are only a few published studies on human-honeyguide mutualism. Wood *et al.* (2014) studied Hadzabe people in Tanzania; hunter-gatherers who collect wild honey with honeyguides. Hadzabe honey-hunters use whistles to attract a honeyguide, and follow the bird when it makes a chattering call and flies towards a bees' nest. While Hadzabe men climb trees (including tall baobabs) to get honeybee honey, Hadzabe women get honey from lower places. Laltaika (2021) and Kilawi (2023) expanded knowledge on honey-hunting practices in other places in Tanzania, and showed that human-honeyguide mutualism is common across different cultures and localities. Kilawi (2023) also showed that, in some case, there exists a mutualistic relationship between honeyguides and beekeepers, as beekeepers use honeyguides to find which of their many hives is ready to harvest. Honey-hunting with honeyguides is also been actively studied in northern Mozambique (Spottiswoode *et al*., 2016; Lloyd-Jones *et al*., 2022; Spottiswoode & Wood, 2023).

2.2.2 Reciprocal interspecies communication

Cooperation ultimately relies on efficient communication between the honeyguide and a human counterpart. The honeyguide tries to attract human attention by making a loud, chattering sound that they only use in this context (Spottiswoode, *et al.*, 2016). They can

also use specific movements to help guide a person to a bees' nest (Isack, 1999). In many cultures where people cooperate with honeyguides, people use sounds to attract the honeyguides. The specific methods of communication can differ depending on the human culture (van der Wal *et al.*, 2022a). In some parts of Africa, people try to attract honeyguides by hitting a tree with axes or other tools or using generic whistles, while in other places people use specific calls or whistles (reviewed in: van der Wal *et al.*, 2022a). In some places, honey-hunters whistle on hollow objects such as snail shells (Isack & Reyer, 1989; van der Wal *et al.*, 2022b), or hollowed-out doum palm *Hyphaene thebaica* nut instruments (Isack & Reyer, 1989) to call the bird. During the cooperative process, the honeyguide appropriately attaches meaning to human signals (Spottiswoode *et al.*, 2016), and has learnt to respond to the calls of their local human culture (Spottiswoode & Wood, 2023).

Spottiswoode *et al.* (2016) states that the vocal sound used by honey-hunters allows them to signal to honeyguides that they are a good prospective human partner that is specifically seeking honey and has the tools, skills, and time to open a bees' nest. They studied the use of a call that the Yao people in northern Mozambique use ('brrrr-hm'), and found that the production of this sound increased the probability of being guided by a honeyguide from about 33 to 66% and the overall probability of finding a bees' nest from 17 to 54%.

Once contact is made between a human and a honeyguide, the honeyguide flies toward the direction of a bees' nest while continuing to chatter (Isack & Reyer, 1989; Laltaika, 2021). The bees' nests are often located in trees, rock crevices, or anthill/termite mounds (Isack, 1999). The humans sometimes make some sounds to keep the bird informed that

it is being followed (Isack, 1999; Spottiswoode *et al*., 2016; Laltaika, 2021). When the bird falls silent, the honey-hunters start searching around to find the actual location of the nest. The bird waits for the human to open up the nest, so that it can access its contents later on (Isack & Reyer, 1989; Spottiswoode *et al*., 2016).

2.2.3 Systems of reward

Whether honey-hunters intentionally reward or do not reward the bird with beeswax after harvesting the honey, is culture dependent (Laltaika, 2021; van der Wal *et al*., 2022a). Some cultures reward the bird, meaning they deliberately leave out wax combs (empty, or filled with brood) for the honeyguide(s) to feed on. The Yao people of Mozambique can even display the wax on a bed of green leaves (Spottiswoode *et al*., 2016). On the other hand, some cultures do not reward the bird, or even actively withhold wax, since these hold the belief that the bird should be kept hungry to keep on guiding them up until they have harvested enough (Wood *et al*., 2014; van der Wal *et al*., 2022b). Honeyguides still benefit from cooperating with honey-hunters in these cases by eating the wax scraps inevitably left behind (Wood *et al*., 2014; van der Wal *et al*., 2022b).

Honeyguides species in Malawi

Out of the 17 species of honeyguides that exist globally (Dunne, 2021), there are six species of honeyguides in Malawi: Scaly-throated Honeyguide *Indicator variegatus*, Greater Honeyguide *Indicator indicator*, Lesser Honeyguide *Indicator minor*, Pallid Honeyguide *Indicator meliphilus*, Green-backed Honeyguide *Prodotiscus zambesiae* and Wahlberg's Honeyguide *Prodotiscus regulus* (Dowsett-Lemaire, 2006). The Greater and Lesser Honeyguides have been recorded before in northern Malawi (specifically in Nyika

National Park and Vwaza Marsh Wildlife Reserve) (Dowsett-Lamaire, 2006). All honeyguide species eat wax. Cram *et al.* (2022) reported that there are anecdotal accounts of people being guided by honeyguide species other than the Greater Honeyguide, including Lesser Honeyguide, Scaly-Throated Honeyguide and Dwarf Honeyguide *Indicator pumilio*. However, further investigation is needed to confirm if and where other honeyguide species also guide humans to bees' nests (van der Wal *et al*., 2022a).

2.3 Safeguarding human-wildlife cooperation

According to ecological theory, interactions between different species can alternate between being advantageous and unfavourable as changes in resources or actions affect the balance of pros and cons for the parties concerned (Chamberlain *et al.*, 2014). For human-wildlife cooperation to occur, four things are needed: motivated humans, animals, a suitable environment, and compatible interspecies knowledge (van der Wal *et al.*, 2022a). However, these components can decline due to environmental or cultural factors such as droughts and inadequate honey-hunting knowledge transition (van der Wal *et al.*, 2022a). Economic and social progress may replace the need for wild honey and thus cooperation with honeyguides with new resource options, such as beekeeping. Fortress conservation bars people from living and hunting in national parks, which can lead to the loss of human-wildlife cooperation benefits (van der Wal *et al.*, 2022a). To safeguard human-wildlife cooperation, there is a need to work together with communities and find ways to protect the environment and cherish traditional knowledge and practices. Lastly, it is important to document what is known for easy access of such information for decision makers and the general public.

2.4 A short history of honey-hunting and beekeeping in Africa

Collecting wild honey is an ancient tradition in Africa (Crane, 1999; Muiruri & Maundu, 2012; Kritsky, 2017), and is key to livelihoods and forest conservation (Lowore *et al*., 2018). In southern Africa, prehistoric rock paintings show that wild honey collection existed at least between 40,000 and 8000 years ago (Pager, 1976). In West Africa, pottery remains show that honey-hunting was important in the early farming setting approximately 3500 years ago (Dunne, *et al*., 2021).

Around 2,000 years ago, people began keeping bees in artificial hives (Crane, 1999). The first beehives were naturally gathered bees in hollowed-out stumps of trees and fallen logs (Crane, 1999; Suson *et al*., 2020). The earliest representation of bees in rock paintings dates from the later part of the palaeolithic period (15,000 to 13,500 B.C.), from caves located in southern France and Spain (Crane, 1999). Drawings of beehives and beekeepers using smoke were also found on the walls of an Egyptian temple built dated approximately 900 B.C. (Roos, 2018).

According to Gruber and Sanda (2019), at least 15 different types of traditional beehives are being used in Africa. The first artificial beehives resembled overturned pots made of clay or straw, with a small opening at the bottom for the bees to freely move in and out (Kritsky, 2017). These so-called “skeps” required that the beekeepers destroy the hive every time they collected honey. Skeps have gradually been joined and/or replaced by: grass hives (grasses woven together in a basket or cylindrical form), gourd hives (pot-shaped with a long neck attached to the “pot” section), log hives (wooden), and clay-port

hives (Kritsky, 2017). In the 18th century, people began using wooden box hives (Crane, 1999).

In the nineteenth century, Thomas Wildman introduced the "bar hive" as a more efficient way of beekeeping (Crane, 1999). Lorenzo Langstroth, a beekeeper and minister, invented the Langstroth hive (Crane, 1999), which is now the most common modern hive used across the globe. Some studies have shown honey production of Langstroth hive and bar hives to be significantly higher compared to log or bark hives (Beyene *et al.*, 2016; Mwandifura *et al*., 2022), while other studies suggested no differences in profitability and revenue advantage (Bradbear *et al*., 2002; Carrol & Kinsell, 2013). Still more, European beekeeping techniques using Langstroth hives are nowadays widely promoted around the world as a sustainable development strategy and to increase pollination (Illgner *et al*., 1998). Lowore *et al*. (2018) emphasises that forest honey is key to livelihoods and forest conservation.

2.5 Beekeeping and honey-hunting in Malawi

Honey-hunting has for long been established as an important activity conducted on the Nyika plateau, serving as a means for livelihood (Davison & Mosley, 1988; McCracken, 2006). Although very little literature can be found on this (but see: Munthali & Mughogho, 1992; Van Blyderveen, 2022), the honey market was probably always fuelled by a mix of honey-hunters and beekeepers. Many beekeepers are actively involved in various beekeeping initiatives supported by government programs and development projects (Van Blyderveen, 2022). Beekeeping is a forestry activity carried out under the supervision of the Department of National Parks and Wildlife (DNPW) and the

Department of Forestry (DoF) (GoM, 2015). Around the protected areas in northern Malawi, the government has granted forest resources for beekeeping, while non-governmental organisations are assisting the initiative by providing beekeeping equipment (e.g., modern honeybee hives, protective gear) and facilitating access to honey markets (GoM, 2006). Beekeeping legally takes place in protected areas, communal forests, and privately owned forests. Beekeepers who work in the protected areas and communal forests have a better chance of receiving government and/or non-governmental organisation assistance, whereas those who work on privately owned land have fewer opportunities (Munthali & Mughogho, 1992).

Beekeeping is an important livelihood for several cultural groups in Malawi, mainly through generating income by selling of honey (FAO, 2022; Van Blyderveen, 2022). The commercial honey industry in Malawi was introduced by development agencies in cooperation with the Malawi government (Kaitano, 2013). The first attempt was a country-wide project under the Department of Forestry (DoF) in 1964 soon after independence in an attempted to reduce deforestation and export beeswax using Langstroth hives (Kaitano, 2013; Van Blyderveen, 2022). Langstroth hives were imported and donated to beekeepers unlike top bar, bark, and log hives which were made locally in Malawi (Ahikiriza, 2016; Amulen *et al.,* 2017; Chazovachii *et al.,* 2012; Van Blyderveen, 2022). In the late 1980s, the German Agency for Technical Cooperation (GTZ), sponsored the Malawi German Bee Development Project (MGBDP) in Nyika National Park and other protected areas (Muwamba, 2014, Kaitano, 2016; Van Blyderveen, 2022). The organisation initiated modern beekeeping to enrich rural communities as a source of income (Novelli, 2007) and as a way to gain their support for wildlife conservation

(Munthali & Mughogho, 1992; Munthali, 2011; Kaitano, 2013). The surrounding communities were allowed to keep bees and collect honey from hives in protected areas (Kaitano, 2013).

Beekeeping has been widely promoted in Misuku Hills, Nyika National Park, Vwaza Marsh Wildlife Reserve, and other places, where honey and beeswax were collected for beeswax export (Coutts *et al.*, 2019; Kaitano, 2013; Munthali & Mughogho, 1992). Some companies and individuals who own real estate and plantations such as rubber, macadamia nuts, and coffee later joined the beekeeping industry (Solidaridad, 2019). Nowadays beekeeping is a traditional part-time occupation practised throughout the country in a variety of landscapes (GoM, 2006).

According to Van Blyderveen (2022), smallholder farmers who make the switch to commercial beekeeping prove that it is a viable livelihood option that can yield substantial income in addition to farming. Since agriculture is Malawi's main source of income and bees are essential to crop pollination, beekeeping and farming go hand in hand. Furthermore, the flowering phases of agricultural crops and forests are staggered, which increases the likelihood of several honey-collecting times and boosts profitability (Kaitano, 2013). The Malawian government is promoting apiculture in rural areas to increase off-farm incomes and job opportunities because subsidies for agricultural resources alone have not improved agricultural conditions (Munthali, 1992; Muwamba, 2014; Salama, 2021).

Despite the effort in the beekeeping industry, extension services in beekeeping are project limited and poorly coordinated between stakeholders and the industry (Van Blyderveen, 2022). Low-level beekeeping training among stakeholders (Kaitano, 2013) indicates that modern equipment and formal training do not guarantee beekeeping success. Similarly, the 'Beekeepers Association of Malawi' (BAM) was once introduced to sustain the marketing of honey and other bee-related products, but did not last beyond the project (Kaitano, 2013; Van Blyderveen, 2022). Despite the growth of the industry, Malawi still produces less honey than other African countries (FAO, 2015; Van Blyderveen, 2022). At present, honey production primarily relies on beekeeping initiatives implemented by various organisations across protected areas, communal land, and privately owned land (Van Blyderveen, 2022), but still more there are possibilities of honey-hunting.

Nothing has been published on honey-hunting practises in Malawi. This study focuses on exploring the methods employed to interact with the honeyguide bird in northern Malawi and thus is worthy of exploring the current situation in Malawi.

2.6 Conceptual framework

The review revealed that bee products are vital to both humans and honeyguides. Eventually, the two parties look for the location of bees' nests. Honeyguides can quickly detect the nest and have a perfect understanding of where bees nest Isack and Reyer, 1989). According to Spottiswoode *et al.* (2016), honey hunters rely on honeyguides to identify wild bee nests. Therefore, this study sought to understand the state of this human-honeyguide cooperation in Nyika NP and Vwaza Mash WR. Several studies have also shown that human calls used to interact with birds are an important component of

cooperative behaviour. Cram *et al.* (2022) and van der Wal *et al.* (2022a) examined the significance of communication between humans and wild animals, especially honeyguides. Interspecific communication between honey-hunters and honeyguides, as well as the maintenance of local calls, is critical (Isack and Reyer, 1989), because birds learn and become accustomed to human-made local calls for communication (Spottiswoode & Koorevaar, 2012). The review goes on to discuss harvesting strategies and how the bird is rewarded; thus, the current study evaluated the local sounds utilised, harvesting procedures, and how the bird is rewarded after guiding. van der Wal *et al.* (2022a) review further emphasised on safeguarding human-wildlife cooperation and the present study specifically target human-honeyguide cooperation. It is established from the review that honey-hunting has registered a great shift due environmental and anthropogenic forces. This study assessed the possible factors that could have contributed to the changes and decline honey-hunting with honeyguides in Nyika NP and Vwaza Mash WR.

The overall goal was to provide a baseline information to help decision makers in and outside protected areas consider honey-hunting as an integral component of human culture. Investigate efforts and best practises for sustainable honey-hunting to preserve the long-term survival of honeyguides and bee populations. Thus has potential to fill the knowledge gap in northern Malawi such that safeguarding measures may be put in place to prevent the honey-hunting culture from being in active in the area.

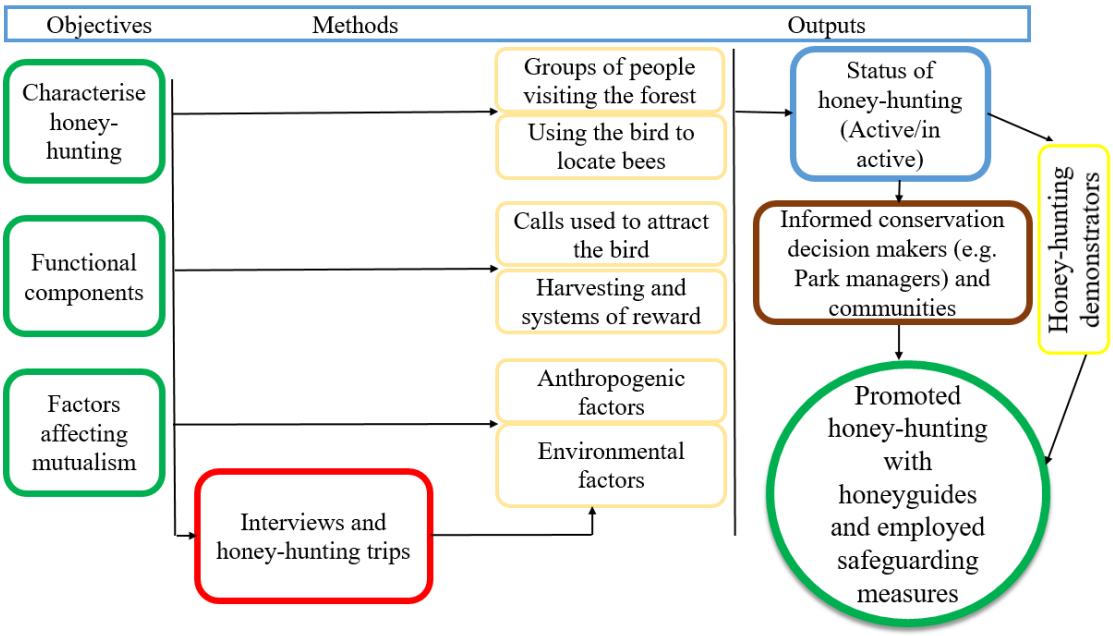


Figure 2: Conceptual framework of honey-hunting with honeyguides.

CHAPTER 3: MATERIALS AND METHODS

This chapter outlines the methodology of this study. The first section describes the study area and the study population. The research design is described in the subsequent subsection, followed by a description of the study's sampling frame and sample size, procedure for data collection, and data analysis.

3.1 Study area and population

The study was conducted in the communities living around Nyika National Park (hereafter "Nyika NP") and Vwaza Marsh Wildlife Reserve (hereafter "Vwaza Marsh WR") (Figure 2), and within the geographic boundaries of Mzimba, Rumphi, Nthalire-Chitipa, and Karonga districts.

The Nyika NP (Latitude*:* -10° 20' 60.00" S; Longitude*:* 33° 36' 0.00" E) covers over 3,000 km^2 of the Nyika Plateau in northern Malawi, about 480 km north of Lilongwe and 60 km north of Rumphi by road. It is a rolling plateau dotted with remarkable mountain outcrops (Dowsett-Lemaire, 1985; Ndhlovu, 2015). The plateau is rich in biodiversity, noted for the endemic herbs and heathers found in its rolling, montane grasslands (GoM, 2015). Nyika NP has a temperate climate with wet and dry seasons (annual temperature ranges from 8 ℃ and 20 ℃) and lies at an altitude of approximately 500 m above sea level (a.s.l) (Dowsett-Lemaire, 1985; GoM, 2014).

Although the Tumbuka people dominate the boundaries of Nyika NP, it should be noted that their other other cultural groups of diverse origins living here. Nyika NP is bounded by Rumphi, Karonga, and Chitipa districts. In Rumphi the Tumbuka is the only dominant

cultural group, whose language is Chitumbuka. Karonga is dominated by the Ngondes whose language is Kyangonde. Chitipa is inhabited by many cultural groups including the Lambyas, Tumbukas, Sukwas, Nyihas, and Namwangas.

Vwaza Marsh WR (Latitude: -11° 02’ 33.00” S Longitude: 33° 46’ 31.08” E) covers an area of about 986 km^2 and is located on mostly low-lying flat land; only the eastern side of the reserve is hilly (Dowsett-Lemaire, 1985). It is located to the southeast of the Nyika plateau and north of the floodplains of the south Rukuru River. Vwaza Marsh WR lies at an altitude range of 1082 m to 1660 m a.s.l (Dowsett-Lemaire, 1985). Its northern boundary coincides with the Malawi–Zambia border. It is bounded by subsistence farmers on the south and east of the Reserve (Engel *et al.*, 2012; GoM, 2014). The wetland alluvial type (281 km^2) constitutes 28% of the total area of the Vwaza Marsh WR (Engel *et al.*, 2012). Vwaza Marsh WR is bounded by Mzimba and Rumphi districts. The Western part of Vwaza is the Zambia boundary. Part of Mzimba is dominated by Tumbuka and Ngoni cultural groups. The side which is in Rumphi district is dominated by Tumbuka people.

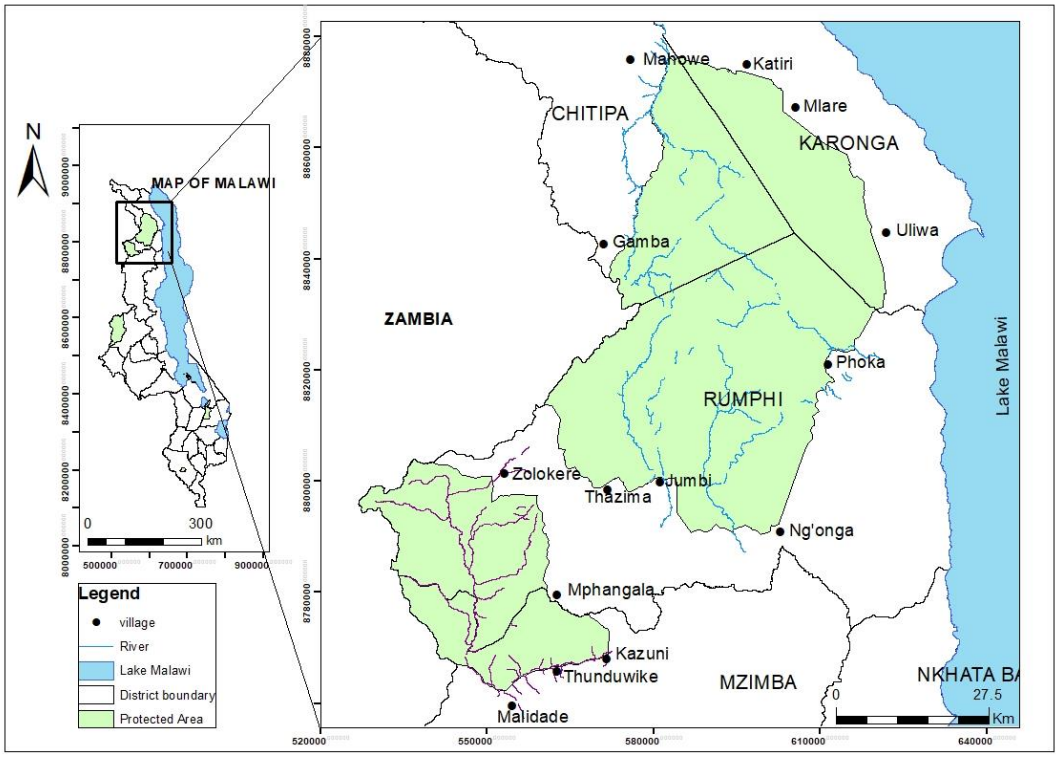


Figure 3: The study area around Nyika National Park and Vwaza Marsh Wildlife Reserve.

3.2 Research design

The study was conducted through the implementation of a cross-sectional design. A cross-sectional design analyses data from a population at one point in time (Olsen & George, 2004). The study used both qualitative and quantitative methods, but all qualitative data were categorized so that all data became quantitative for analysis.

3.3 Sampling framework and methods

To select the sampling points (i.e. villages) where honey-hunters are located, a purposive sampling design was used (Van Ryzin, 1995). In each village, to identify as many expert honey-hunters as possible, the researcher used snowball sampling, thus, asking each interviewee who should be the next people to sample (Naderifar *et al.*, 2017). The

intended sample size was approximated using Cochran's formula (Cochran, 1977). The research participants were identified through cooperation with the traditional leaders of the villages and the extension workers of the Department of National Parks and Wildlife (DNPW).

In addition to expert honey-hunters (n = 67), the researcher also interviewed several honey-hunters that also kept bees (n = 52) and 7 expert beekeepers (who did not honey-hunt). Two respondents were excluded from analysis: (1) one Namwanga respondent given he was not a honey-hunter or beekeeper, but a honey trader, and (2) one Tumbuka respondent given she was a village chief who was raised in an urban environment and did not have experience in honey-hunting and beekeeping. Thus, the total sample size analysed was 126 respondents, from 25 villages. The respondents came from the following cultural groups: Tumbuka (n = 102), Ngonde (n = 13), Ngoni (n = 8), Chewa (n = 4), and Namwanga (n = 1).

3.4 Data collection

The data for the present study were obtained between 1 July 2022 and 10 October 2022. To address all three objectives, semi-structured interviews were used to collect data from respondents in the sampled communities (Appendix 1). All the interviews were conducted in Chitumbuka, which is the common language in northern Malawi. Prospective respondents were given an overview of the research aims and requested to provide written informed consent for their participation and recording of the interview (Appendix 2).

Respondents were asked a range of questions about their honey-hunting practices. For instance, on the relevance of honey-hunting in their livelihood and culture, their familiarity and interactions with honeyguides, as well as their perception of change over time in their honey-hunting practises. They were also asked about their incentives to honey-hunt, and from whom they learnt the skills. Pictures of a juvenile and adult honeyguide, golden tailed woodpecker *Campethera abingoni*, and honey badger were presented as part of the interview (Appendix 3). The researcher audio-recorded and took notes from each interview. At the end of the interview, any calls used to communicate with honeyguides were recorded.

In addition to the interviews, the researcher attended four honey-hunting trips in different places with different honey-hunters (with 1 Ngonde, 1 Ngoni, and 2 Tumbuka respondents), to verify what was reported in the interviews. During these honey-hunts, the researcher noted and recorded calls used to attract and follow the honeyguides and documented the honey-harvesting process (e.g. tools used). The researcher took pictures and notes from these observations, to give a careful general description of this process.

3.5 Ethical consideration

This study obtained ethical clearance from Mzuzu University Research Ethics Committee (approval code MZUNIREC/DOR/23/21) and the University of Cape Town (approval code FSREC 012-2022).

3.6 Validity and reliability

The consent form and questionnaire were translated and made available in Chitumbuka to ensure that respondents understood the questions and provided meaningful responses. During the interviews, only one respondent interviewed at a time, with no other possible respondents or family members present to interfere or listen. The entire conversation was taped with an audio recorder in case the researcher missed something while taking notes. During honey-hunting events, the researcher recorded the calls used to interact with the honeyguide, in addition to taking pictures and notes, to ensure that the data accurately reflected the honey-hunting process.

3.7 Study limitations

Given that this was the first study of its kind in Malawi, the researcher proposed stratified sampling, which involved grouping individuals based on cultural groupings in the areas surrounding Nyika NP and Vwaza Marsh WR. However, the researcher realised in the field that the most prevalent cultural group in the study area was Tumbuka. The other cultural groups reside far from the reserve or coexist with Tumbukas close it. Therefore, purposive sampling was adopted instead, as the researcher was unable to compare honey-hunting activities among cultures. This topic has a limited literature base because scientific studies on honey-hunting have only been conducted in a few places in Sub-Saharan Africa. The study required the researcher to spend a lot more time in the field to collect more data because the respondents were spaced very far apart, and the interviews took thirty to sixty minutes to complete. Some respondents were unable to provide accurate information and/or refused to answer questions while holding substantial knowledge because they suspected the researcher of being a park ranger. The researcher

could not afford to pay honey-hunters who sought money for services such as going on a honey-hunting trip. The researcher was unable to reach several of the sampled places where honey-hunting was known to be done due to their inaccessibility.

3.7 Data analysis

After translating the recordings and coding data from the interviews to English, data was entered into Microsoft Excel 2013. Statistical programme R version 4.2.2 (R core team 2022) was used for all data processing, analyses, and visualisations to address all three study objectives. Responses per question were pooled across cultural groups, given that they live together, and the honey-hunting and beekeeping practises were found to be very similar. In the case of categorical answers to interview questions, the count for each category was summed per occupation (beekeepers, honey-hunters, and those that practise both beekeeping and honey-hunting). Several bar plots were made to facilitate visualisations of categorical frequencies.

As part of the first objective, which was to characterise honey-hunting with honeyguides, the researcher tested whether the litre price of the honeybee and stingless bee honey differed between beekeepers, honey-hunters and those that practice both. To achieve this, a general linear mixed model (GLMM) was used, in which the litre price was the response variable, the occupation (honey-hunter, beekeeper, and those who do both) was the predictor variable, and the village was included as a random factor (Appendix 4). This was accomplished through the use of the "lme4" package (Bates *et al.*, 2015). P-values for GLMMs were derived by using the Anova function in the "car" package (Fox & Weisberg, 2019), which calculates Type III Wald chi-square tests. P-values for all

pairwise comparisons of occupations were done with the emmeans function in the "emmeans" package (Lenth, 2022). The expected normality and homogeneity conditions for GLMMs were evaluated by visually examining the residuals and normal probability plots (Appendix 2).

CHAPTER 4: RESULTS

This chapter presents the main findings of the study objectives. The chapter describes the characterisation of honey-hunting with honeyguides, the calls used to communicate with honeyguides and harvesting techniques, and finally the threats and causes of decline in honey-hunting with honeyguides.

4.1 Descriptive results

Out of the 126 individuals interviewed, 8 (6%) were female and 118 (94%) were male. They belong to four different cultural groups (Chewa, Ngoni, Ngonde, Tumbuka), with the dominant cultural group being Tumbuka (101; 80%) (Table 1). Out of 126 respondents, 119 respondents reported having honey-hunted, either recently (in the past year; n = 84) or in the past (longer than one year ago; n = 35). The remaining 7 respondents were beekeepers only (Table 1). The respondents reported having different sources of livelihood, and the most reported source of livelihood was farming (36%) followed by beekeeping (30%) and then honey-hunting (20%). Very few respondents reported relying on employment (10%) and other type of businesses (4%).

Table 1: Summary of demographic characteristics and occupation of respondents in the study area.

Characteristics	**Tumbuka (*n*=101)**	**Ngonde (*n*=13)**	**Ngoni (n=8)**	**Chewa (n=4)**	**Total (*n*=126)**
Number of respondents, *n* (%)	101 (80)	13 (10)	8 (7)	4 (3)	126 (100)
Gender of respondents, *n* (%)					
Female	6 (75)	1 (13)	0 (0)	1(13)	8 (6)
Male	95 (81)	12 (10)	8 (9)	3 (3)	118 (94)
Occupation, *n* (%)					
Honey-hunter	51 (51)	12 (92)	2 (25)	2 (50)	67 (53)
Both	45 (45)	0 (0)	6 (75)	1 (25)	52 (41)
Beekeeper	5 (5)	1 (8)	0 (0)	1 (25)	7 (5)

4.2 Characterising honey-hunting with honeyguides

4.2.1 The importance of honey and other bee products

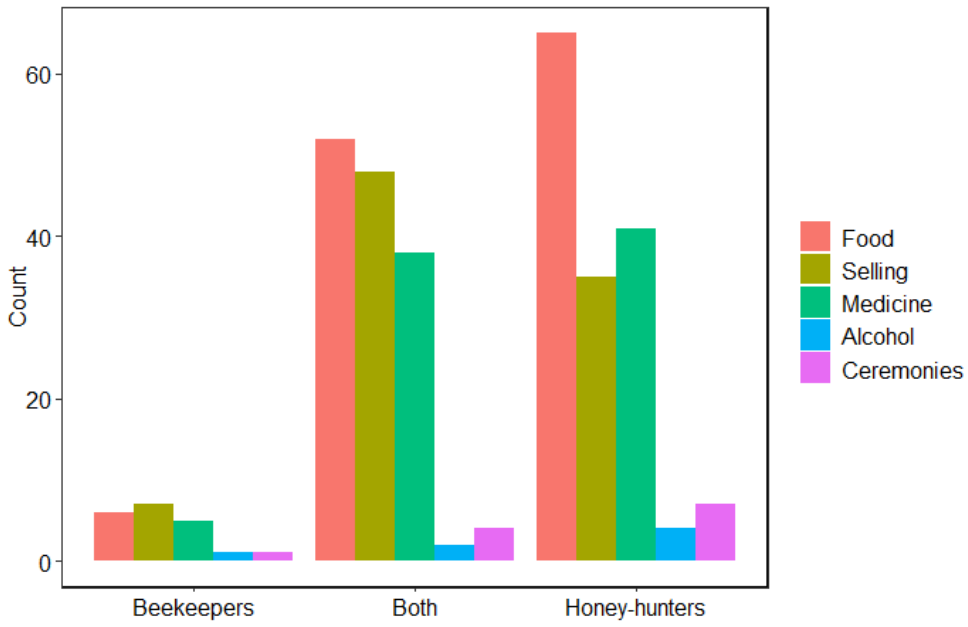
The researcher wanted to find out how honey is used among people in northern Malawi. All respondents reported using honeybee honey. Across all cultural groups, respondents mostly used honeybee honey as food, to sell, and as medicine (i.e. to treat coughs, ulcers, and wounds) (Figure 3A). The use of honeybee honey in cultural ceremonies and brewing beer was relatively rare, with only limited usage among respondents, respectively (Figure 3A).

Out of all respondents, 105 (83%) made use of stingless bee honey (referred to as: ”*Mphasi*”, “*Bonga*”, and “*Munya*”) for various purposes: for consumption (38%), trade

(33%), and medicinal purposes (29%) (Figure 3B). Honey from some species of stingless bees such as "*Mphasi*" was considered to be equally valuable to honeybee honey.

Out of 119 honey-hunters, 63 individuals (53%) reported also (occasionally) eating wax combs filled with brood. It is generally described as an important source of protein among the communities. Seventeen respondents mentioned that they use beeswax to straighten wooden tools such as hoe handles, and 20 beekeepers reported that they use beeswax to make candles.

(A)



(B)

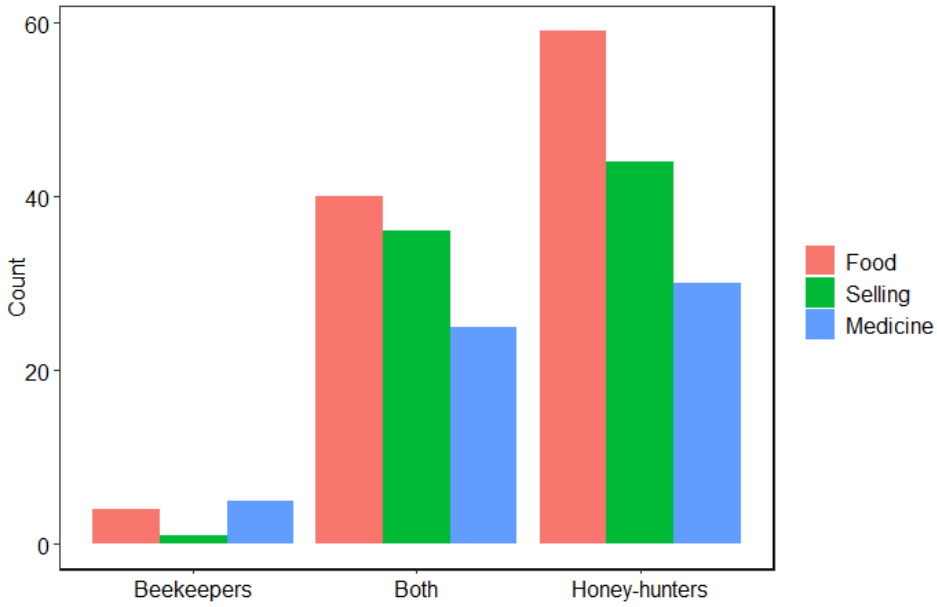


Figure 4: Honey usage among beekeepers (n = 7), those practising both honey-hunting and beekeeping (n = 52) and honey-hunters (n = 67) for honeybee honey (A) and stingless bee honey (B). Note that some respondents gave multiple answers, hence, the bars don't add up to 100%.

4.2.2 Value of honey among communities

When asked how important honey was for their livelihood, 65 respondents (62%) said it was an additional source of income (besides their main source of income; mainly agriculture), 17 respondents (14%) said it was their main source of income, 10 respondents (8%) said it was a very occasional source of income, and 34 respondents (27%) did not sell honey and said honey was only used for consumption. 109 respondents (87%) reported that they harvest stingless bee honey as well, of which 81 (74%) reported selling the stingless bee honey harvested. Informal conversations with 15 respondents revealed that the quantity of honey harvested from stingless bees is lower compared to honeybee honey, and since it is not that common to find, it is rare to find it at markets.

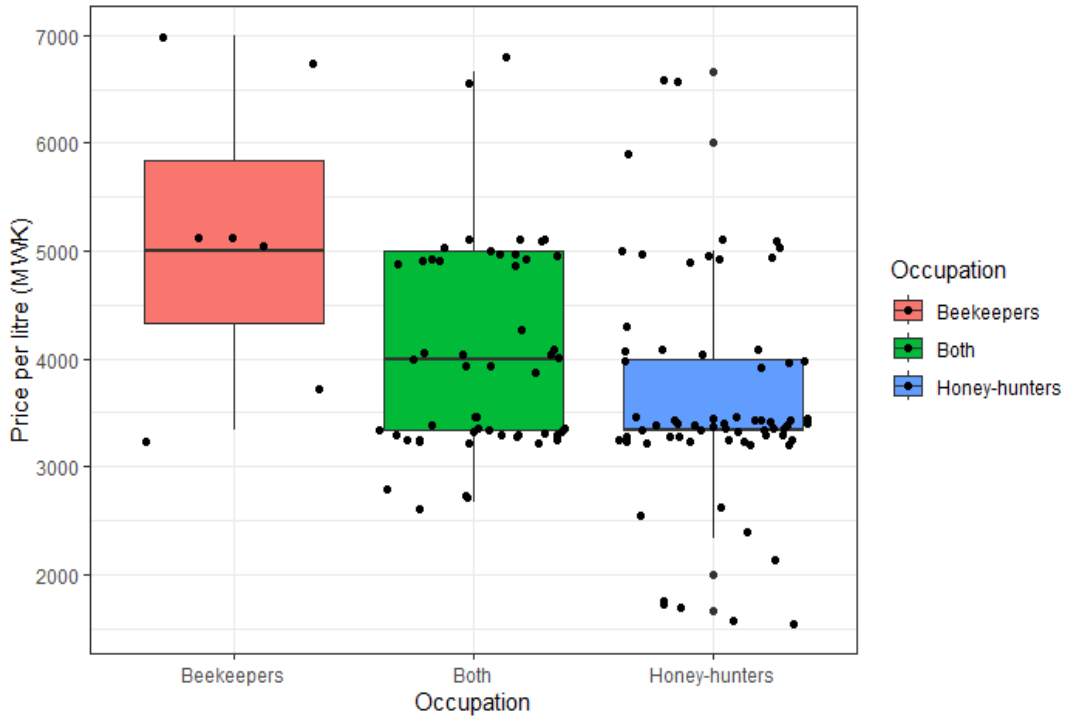
One hundred and eleven (111) out of the total of 126 respondents 97 (87%) reported not using honey to barter, while 14 (13%) reported bartering honey, mainly for foods such as maize and chicken. More than half (58%) of honey-hunters (69 out of 119) reported to honey-hunt more when crops fail. In times of hunger, honey-hunting is a crucial activity to generate food, income and for bartering to meet livelihood demands.

One honey-hunter reported collecting wild honey that causes hallucinations in/around Nyika NP. He reported to have been collecting wild honey since childhood and he happened to encounter the strange honey that could make him feel like he is drunk. He suspects that there are certain tree species in which the bees nest, and collect nectar from that causes their honey to have hallucinogenic properties.

Respondents reported the price of honeybee honey and stingless bee honey per 300 ml gin bottle. The price of honey was transformed into a per-litre unit by applying a multiplication factor of 3.333 to the original price per 300 ml. The mean ± SE reported price per litre of honeybee honey was 3865 ± 0.77 MWK (ranging from 1667 to 7000 MWK, or US$ 1.6-6 USD). There is a significant difference in the average reported price per litre of honeybee honey amongst beekeepers, those who practise both, and honey-hunters (GLMM, $\chi 2 = 14.21$, Df = 2, $p < 0.001$; Figure 4A, Appendix 2). Beekeepers reported a considerably higher unit price in comparison to honey-hunters and individuals engaged in both honey-hunting and beekeeping activities. The results of the pairwise comparison indicate statistically significant differences between beekeepers and honey-hunters ($p = 0.001$), as well as between beekeepers and individuals who engage in both activities ($p = 0.006$). However, no statistically significant difference was observed between honey-hunters and individuals who practise both activities ($p = 0.522$).

The mean ± SE reported price per litre of stingless bee honey was 3428 ± 0.42 MWK (ranging from 1667 to 5000 MWK, or 1.6–4 USD). Honey-hunters and those who practise both did not significantly differ in the reported average litre price of stingless bee honey (GLM, $\chi 2 = 2.34$, Df = 1 $p = 0.126$; Figure 4B).

(A)



(B)

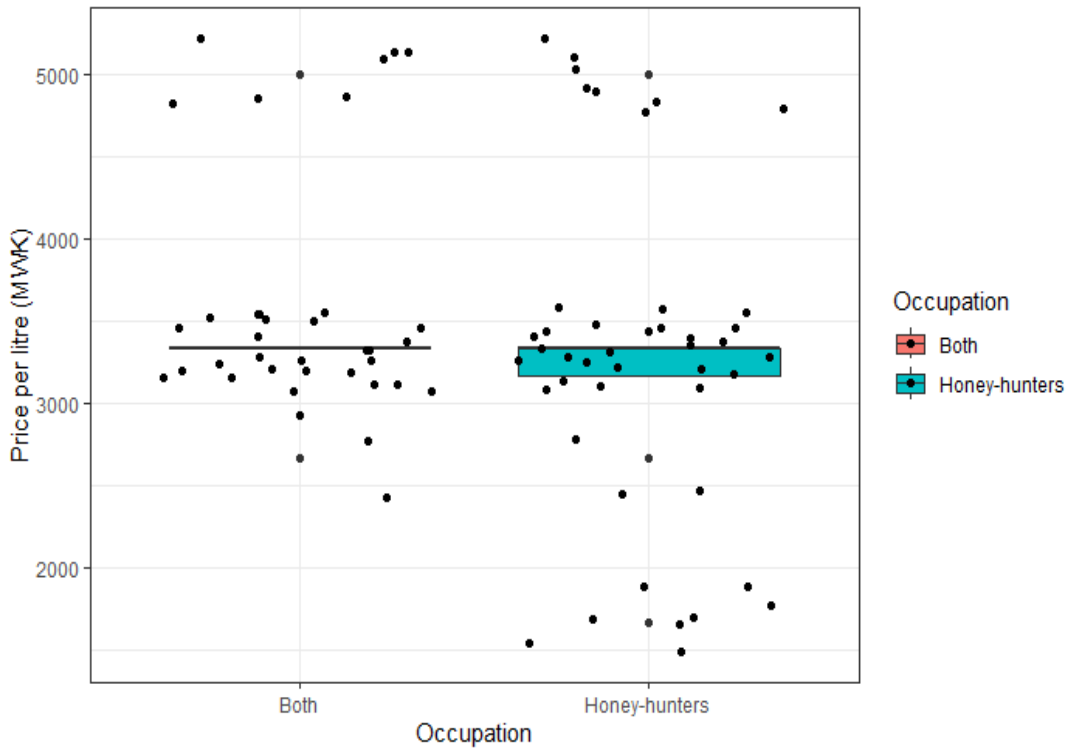


Figure 5: The litre prices reported for: (A) honeybee honey (n = 126 respondents) and (B) stingless bee honey (n = 80 respondents; excluding 1 beekeeper that reported selling stingless bee honey).

4.2.3 Use of honeyguides among the communities

The honeyguide is commonly known as "*Solo*" in Tumbuka. The bird is believed to bring good luck, and harming it brings bad luck. Out of the 119 expert honey-hunters and those who both honey-hunt and keep bees, 112 (94%) attested to using honeyguides as a means of locating wild honeybee bees, while 7 (6%) never used the bird. Out of 119 honey-hunting respondents, 91 (76%) said they collect honey from stingless bees, and 46 (51% of 91) of them mentioned using honeyguides to locate stingless bees' nests. Honey-hunters reported that they employ a careful approach in following the chattering honeyguide as it flies from tree to tree, until it eventually falls silent and circles a designated location or lands on a perch. This indicates the location of a bees' nest. Honey-hunters then conduct extensive searches of the surrounding area until they successfully locate the nest. Moreover, nineteen honey-hunters mentioned that honeyguides are also known to be killed for rituals by healers, based on the believe that they are a source of luck.

4.2.4 Honey-hunting trips

The majority of honey-hunters (66%; 79 out of 119) reported that they don't plan for honey-hunting trips, and rather honey-hunt while herding cattle and doing other activities in the forest, while 39% (46 out of 119) of respondents said that they plan for honey-hunting trips. On average, respondents go honey-hunting five times per month, the mean ± SE reported number of trips per month that people went for honey-hunting was 5 ± 0.32 times (ranging from 1 to 16 trips per month). 108 (91%) of respondents said that their honey-hunting trips last up to a day, while 11 (9%) respondents said that they typically go on honey-hunting trips that last more than one day.

Honey-hunting is predominantly carried out in teams, rather than individually: 70 individuals (59%) consistently honey-hunted with others, 24 individuals (20%) frequently honey-hunted with others, 19 individuals (16%) primarily honey-hunted alone, and the remaining 6 individuals (5%) always honey-hunted alone (Figure 5).

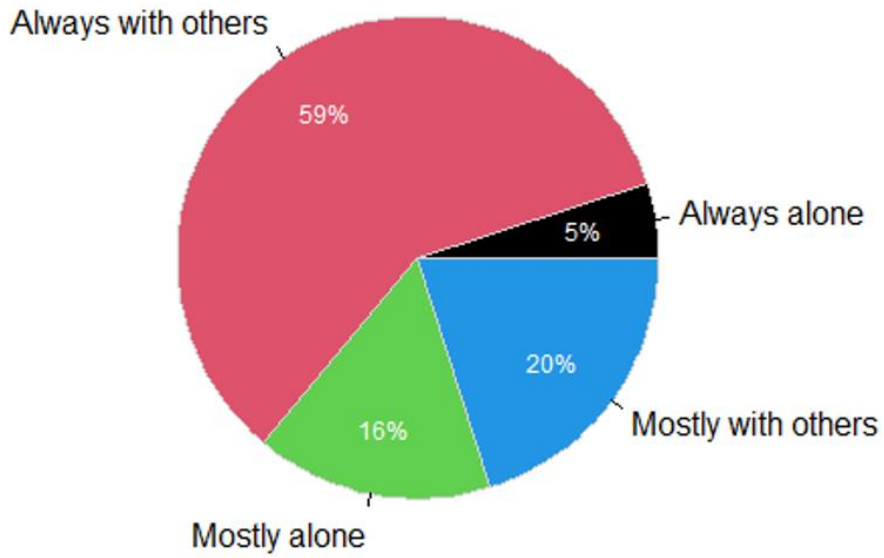


Figure 6: Honey-hunting team composition (n = 119), depicting that honey-hunters mostly practise honey-hunting in groups.

4.2.5 How and when do people learn honey-hunting?

Most respondents reported that they learnt how to honey-hunt from elders. Out of the 119 honey-hunters (including those who both honey-hunted and kept bees), 90 (76%) reported to have learnt from their parents (father and/or mother), 13 (11%) learnt from their grandparents, 9 (8%) learnt from peers, and 7 (6%) learnt from other family members. Honey-hunters are reported to have learnt to honey-hunt when they were young. Out of the 119 honey-hunting respondents, 106 (89%) reported having started honey-hunting

when they were younger than 20 years old. The mean ± SE reported age at which respondents honey-hunted for the first time was 14 ± 0.37 (ranging from 8 to 25 years old).

4.3 Functional components of human-honeyguide mutualism

4.3.1 Calls used by humans to communicate with honeyguides

To recruit honeyguides, individuals who engage in honey-hunting (n = 119) reported using a range of signals to communicate with honeyguides. The calls that honey-hunters used in northern Malawi to attract honeyguides ranged from more general sounds such as striking a tree with a tool (n = 44; 22%), to specific, such as blowing air between their hands ("*Chimpheta"*) (n = 54; 29%; mostly used by Tumbuka people), blowing air through a hollow instrument like an animal horn or a wooden tool (Figure 6; n = 13; 7%; mostly used by the Ngonde and Tumbuka), and whistling (n = 59; 32%). Similar blowing instruments were also reported to be used by game hunters to attract animals as a trap to be killed.

Second, honey-hunters used coordination calls to maintain communication with the honeyguide during the guiding process. The process of making a coordination call with the honeyguide is known as "*kukonkhezga solo*" in Chitumbuka. For 69 honey-hunters (58%), the coordination call is the same as the recruitment call, while the other 50 honey-hunters (42%) used a different call. Overall, coordination calls included: making a whistling sound (100; 63%), words to praise the honeyguide (mentioning the name of the bird e.g. "*iwe ndiwe solo*" meaning "you are the honeyguide"; asking it to not lie and tell the truth, and give food to the poor: "*chilela walanda*""; (32; 20%), general whistle with

words (25; 16%) and hand whistle (3; 2%). According to one of the Ngoni respondents, their forefathers observed the honey badger making this "*mhii mhii*" sound while following the honeyguide and eventually copied the sound which now became a tradition, thus it is passed down from generation to generation.

(A) (B)

Figure 7: Blowing instruments (A) animal horn and (B) hollow wood instrument used to attract a honeyguide to start the guiding process.

4.3.2 Honey harvesting during honey-hunting

Respondents who honey-hunt (n = 119) use axes and hoes to access the contents of bees' nests (Figure 7A). When the nest is on the ground, a hoe is typically used to dig it up, and in rocky areas, a sharp, strong metal is sometimes used to harvest the nest (reported by 10 respondents). When the location of the nest is in a tree, honey-hunters open, with an axe, a small-sized hole on the entrance to harvest. In the case of some bees' nests that are not easily accessible, 16 honey-hunters reported making and using temporary ladders made out of poles and ropes made from other plant materials to climb up trees to reach bees' nests. 100% of honey-hunters use fire and smoke to subdue the bees. One of the respondents reported that they burn animal dung and use the smoke from the dung to

subdue the bees. Eighteen respondents commented that some of the bees die from the use of smoke and fire. Those that practise both beekeeping and honey-hunting sometimes use gloves, bee suits and smokers to harvest the hives.

Personal observation during four honey-hunting trips and informal conversation with 28 respondents indicated that it is common for honey-hunters to fell a tree (Figure 7A). Forty respondents, however, reported not felling the tree but instead enlarging the bees' nest opening to expose the honey, especially when they wished to harvest it again in the future. To enable this, the enlarged openings are then sealed with a rock to encourage the bees to stay there (Figure 7B). Sometimes bees' nests were also dug up from the ground.

(A) (B)

Figure 8: (A) Honey-hunters usually use an axe to bring down a tree, break open the nest, and then introduce smoke and fire to extract the contents. (B) One effective method for harvesting is to open the nest, collect the contents and then seal it again to ensure that the bees remain in their habitat.

4.3.3 Systems of reward

Hundred and eleven of the respondents who honey-hunt (93%) actively reward honeyguides for their help. The bird is rewarded for guiding humans with wax combs filled with brood (81% of respondents), scraps or leftovers (8%), and sometimes wax combs with honey (3%). Those that did not actively reward the bird (n = 8) still believe that the bird will feed on leftovers left behind after harvesting.

Honey-hunters mentioned several reasons for rewarding honeyguides with wax combs filled with brood and beeswax: 49% of the respondents believe it is meant to motivate leading humans again in the near future, 27% of the respondents see it as a gesture of appreciation, 11% of the respondents have reported that they have been instructed by elders to always give a reward to the honeyguide, and 8% of respondents believed the honeyguide should be rewarded to avoid being led to danger. Three honey-hunters explained that the bird, in certain instances, should not be rewarded substantially as an incentive for it to facilitate the discovery of more nests in that same honey-hunting trip.

Many respondents believed that not rewarding the bird has negative consequences. Out of the 111 respondents who said they reward honeyguides for guiding them to a bees' nest, 43% (n = 48) of respondents hold a belief that the bird may not guide them or others in the future if it is not given an incentive. Twenty-five respondents (23%) reported that depriving a bird of bee products is believed to bring about bad luck and misfortune during subsequeny honey-hunts, of which 10 respondents said that honeyguides will lead you to a dangerous animal next time.

4.3.4 Honeyguides guiding to other things

In addition to the nests of honeybees and stingless bees, 89 honey-hunting respondents (75%) reported that the honeyguide also leads humans to man-made beehives. The study revealed that 81 out of 119 honey-hunting respondents (68%) had also experienced a honeyguide guiding them to wild animals, of which the majority (73 individuals) reported being guided to large snakes. More rarely, respondents reported being guided to other animals (8 respondents): an elephant, a wild cat, or an eland.

Of the 81 respondents who were led to wild animals, 49% believed that they were being warned of danger, 13% attribute it to being unlucky, 25% thought the honeyguide would like the honey-hunter to kill the animal, 3% of the respondents thought the bird confused flies around a snake with bees. The remaining 9% did not give any reasons as to why the bird led to another animal since they were not sure of the bird's intention.

4.3.5 Ownership of wild nests

Seventy-seven percent of honey-hunters reported using measures to prevent others from harvesting nests that they had previously discovered. They use various marks to indicate to fellow honey-hunters that they have already claimed the nest, and avoid others from harvesting it. The presence of a marking indicates to them that the identification of the nest has already been made. Other ways to signal to fellow honey-hunters to refrain from gathering honey from the specified nest include: removing a tree's bark (reported by 13 respondents, 10%), fastening a rope or cluster of grass on the tree (26 respondents, 22%; referred to as "*kukaka mkusa*"), closing the opening with a stone (11 respondents; 9%), leaving signs of fire or burn the grass around to pretend it has already been harvested (2

respondents; 2%) or snapping off a branch from a different tree and position it nearby (38 respondents; 32%; referred to as "*kutemera thole*").

Five elderly persons reported that if a nest had a marking, another honey-hunter would be hesitant to harvest it due to regard for such marks or the chance of encountering curses or spells. However, these elder respondents claimed that the current widespread practise of showing disrespect to others has eroded the respect that was once normal. Even with a clear signal, some individuals in this generation believe that wild bee nests are openly accessible to everyone, thus they sometimes harvest nests marked by others.

4.4 Threats and causes of decline of human-honeyguide mutualism

4.4.1 Perceived changes in honey-hunting practise

The researcher wanted to know if the practise of honey-hunting had changed over time. Eighty-six percent (86%) of respondents (n = 102) believe it has changed since they were children, while 14% (n = 17) believe it has not changed. Respondents argue that honey-hunting practises have changed for a variety of reasons: the loss of large trees (36%); growing popularity of beekee (14%) and limited access to protected areas for honey-hunting has caused many to refrain from honey-hunting (8%).

4.4.2 Perceived changes on the role of honeyguides

When asked about perceived changes in the role of ping (25%); a decline in honeyguide populations (17%); loss of natural bee populations honeyguides in honey-hunting specifically, 47 out of 119 respondents (39%) reported that the bird's behaviour had not changed, while 72 out of 119 respondents who honey-hunted (61%) reported that the

bird's guiding role had changed. Out of the 72 respondents who thought this had changed, 17% (n = 12), stated that the bird had started guiding them to beehives; 44% (n = 32) mentioned habitat loss, (14%, n = 10) indicated scarcity of wild bees, and (25%, n = 18) reported scarcity of honeyguides in their vicinity.

Further informal discussion with nine respondents revealed that they have reduced the use of loud-blowing instruments to attract honeyguides. This is because poachers have lately been using blowing instruments to imitate animal sounds: therefore, honey-hunters do not want to be mistaken for a poacher by rangers.

4.4.3 The future of honey-hunting with honeyguides

The researcher wanted to know the perception of respondents on whether the interaction will continue in the future or not. Eighty-one respondents (68%), suggested that the mutualism will not continue (Figure 8). The remaining 38 respondents (32%) out of 119 reported that the mutualism will continue. Of the 68% respondents who proposed the mutualism will stop to exist, the reasons given were: the rising popularity of beekeeping among communities (55%, n = 45); increased access to Western education by the upcoming generation (18%, n = 15); loss of interest in honey-hunting by the younger generation (14%, n = 11); loss of knowledge in future generations (9%, n = 7); loss of honey-hunting habitat with honeyguides (4%, n = 3). Of the 38 respondents said they thought honey-hunting with honeyguides *will* exist in the future, the majority (n = 24, 63%) thought the interaction would continue in reserves where there is less disruption to the environment, and 14 respondents (37%) reported that their children are learning and will carry on the tradition.

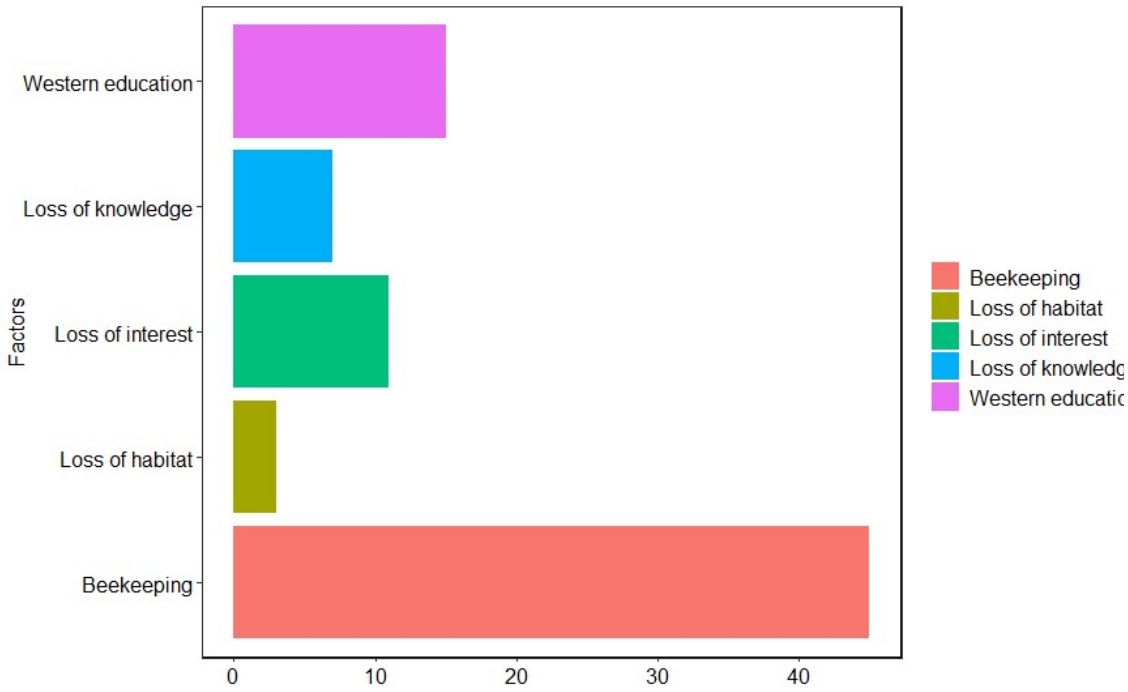


Figure 9: Factors perceived by respondents as affecting honey-hunting with honeyguides not to continue in and around Nyika National Park and Vwaza Marsh WR.

Respondents were asked how human-honeyguide cooperation would change in the future. Eighty-seven percent 87% of respondents (n = 104) indicated that they thought the human-honeyguide mutualism will change in the future, and 13% (n = 15) respondents predicted that the interaction will not change. Of the 104 respondents who thought the mutualism dynamics will change, 56% of respondents (n = 45) reported that around Nyika NP and Vwaza Marsh WR, Malawians have adopted beekeeping, which will completely overshadow honey-hunting beyond the current status. Fourty-four percent of the respondents (n = 36) argued that the loss of habitat for honeyguides and bees will prevent future generations from experiencing honey-hunting with honeyguides. Of those who

believed the interaction will not change, 13% reported believing that their 49tipulat will uphold the honey-hunting skills and practices.

4.4.4 Cultural changes in honey-hunting

All respondents were taught to use honeyguides by their parents, relatives, or peers (see Section 4.2.5). According to the study findings, the mean ± SE age of individual respondents who are active honey-hunters was 45 ± 0.51 years (ranging from 12 to 71 years). The percentage of active honey-hunters in the age bracket <30 years old and ≥30 years old, is 19% (15 out of 79) and 81% (64 out of 79) respectively. Informal conversations with expert honey-hunters and observations made during four honey-hunting trips reveal that the young generation is discouraged to honey-hunt, because the only places where honey-hunting is still profitable is in the National Parks and Wildlife Reserves, where it is illegal to do so, and the legal consequences are large.

4.4.5 Beekeeping practices

Of the 59 respondents who reported to be involved in beekeeping, 42 respondents (69%) used wood cylinder hives, 17 respondents (28%) used box hives, and 2 (3%) used clay pot hives. From the researcher's observations, communities use any available tree as far as they can be able to make a hive from it, regardless of the conservation status of the tree. Some of the indigenous tree species used for making hives were observed to be Mtondo *Codyla Africana*, Muwanga *Pericopsis angolensis*, Mombo *Brachystegia speciformis; B. manga, B. stipulate,* and Mkula *Pterocarpus tinctorius*.

Despite the reported increase in beekeeping among cultural groups around Nyika NP and Vwaza, Marsh WR, honey-hunting remains an important activity for expert honey-

hunters. Respondents expressed a preference for honeybee honey from wild bees over honeybee honey from beekeeping. Wild honey produced by wild bees' originating from both honeybees and stingless bees, is thought to contain a higher concentration of natural pollen derived from various plant sources. This appears to confer the ability to heal a variety of diseases not present in honey sourced from some conventional beehives placed in less diverse forest tree species.

(A) (B)

Figure 10: (A) A wood cylinder hive (B) a box hive. (C) Wood cylinder hive crafting from *Pterocarpus tinctorius*.

CHAPTER 5: DISCUSSION

This study investigated the honey-hunting culture and the ecological relationship between honeyguides and honey-hunters around Nyika NP and Vwaza Marsh WR in northern Malawi. A comprehensive study was conducted to obtain relevant insights by conducting face-to-face interviews with a total of 126 respondents in 15 rural communities surrounding Nyika NP and Vwaza Marsh WR. The study has characterised honey-hunting with honeyguides; described functional components of human-honeyguide mutualism and identified the threats and causes of the decline of human-honeyguide mutualism.

5.1 Summarised main findings

The findings of this study have shown that honeybee honey products have a high value around Nyika NP and Vwaza Marsh WR in northern Malawi. Local communities surrounding Nyika NP and Vwaza WR continue to engage in honey-hunting and cooperate with honeyguides to do so. To attract honeyguides, they use various methods to create sounds, such as striking a tree with a tool, whistling by blowing air between their hands ("*Chimpheta*"), and more rarely: blowing instruments. Honey-hunters use an axe to harvest the nests in trees, while smoke and fire are used to subdue the bees. They primarily collect honey-containing wax combs, but they also collect brood-containing wax combs. Most honey-hunters reward the honeyguides with wax combs filled with brood. There is a reported decline in honey-hunting with honeyguides, which is attributed to a decrease in the availability of suitable honey-hunting habitat, gaining popularity of beekeeping, and a decrease in interest by the youth.

5.2 Characterising honey-hunting with honeyguides and functional components of human-honeyguide mutualism

5.2.1 Use of honey among communities

Both honeybee and stingless bee products are widely used and valued among respondents in the study area as sources of sugar and protein. Honey is used as food, medicine, and for sale, and several studies across sub-Saharan Africa are sharing the same findings (Van Zwanenberg, 1976; Kenny, 1981; Isack & Reyer, 1989; Isack, 1999; Wood *et al.*, 2014; Gruber, 2018; Laltaika, 2021; Marlowe *et al.*, 2014; Kilawi, 2023; Van Blyderveen, 2022). Honeybee brood is also used by some respondents in the study area as relish which is believed to be very good. Similary, Laltaika (2021) found that communities in northern Tanzania use bee brood as relish. Crane (1999) and Isack (1999) also described honeybee brood as an important source of proteins and sometimes valued more than honey. Honeybee honey is also used by communities around Nyika NP and Vwaza Marsh WR for making local beer and for ceremonial purposes though it is not currently a common practise. It was found to be a common practise to use honeybee honey for ceremonies and making local beer in both southern and northern Tanzania (Laltaika, 2021; Kilawi, 2023). Isack (1999) emphasised the use of honeybee honey together with Kigeria African fruits for brewing beer among the Boran people in Kenya.

5.2.2 The economic value of honey

The findings showed that wild honey collected through honey-hunting with honeyguides is often sold and thereby an important source of income. The findings agree with other researchers in Africa who reported that honey-hunting is an important livelihood activity

(Isack, 1999; Spottiswoode *et al*., 2016; Laltaika, 2021; van der Wal *et al*., 2022b; Kilawi, 2023). Apart from just selling honey for cash, the reported bartering for other foods in times when crops fail, show that honey is an important food substance that contributes to sustenance of communities living around the reserves.

The most common type of honey found on the market is honeybee honey. This study found that beekeepers in the study area sell honeybee honey at a higher price compared to honey-hunters. This is similar to what Laltaika (2021) and Kilawi (2023) reported in northern and southern Tanzania, respectively. The reasons could be due to the increase in popularity of beekeeping and the assumption that honey produced through this method is superior in both quality and quantity. However, despite this, expert honey-hunters (those who practise hone-hunting only) place high importance on the wild honey obtained from wild bees' nests something that some consumers do not know. According to the respondents, stingless bee honey was sold at a lower price compared to honeybee honey. This can be explained by the variation in the quality, quantity, and perceived low value of stingless bee honey over honeybee honey.

5.2.3 Use of honeyguides among communities

This scientific study is the first to confirm that, around Nyika NP and Vwaza Marsh WR in northern Malawi, honey-hunters and honeyguides cooperate to access the content of bees' nests. These findings agree with the scientific studies in Kenya (Isack & Reyer, 1989; van der Wal *et al.*, 2022b), Mozambique (Spottiswoode *et al.*, 2016); Tanzania (Wood *et al.*, 2014; Laltaika, 2022; Kilawi, 2023). According to reports from expert honey-hunters, locating nests without assistance from honeyguides poses a considerable

challenge. This study contributes to the expanding body of knowledge indicating that the ability to locate wild honeybee nests in the absence of honeyguides is a challenge to human individuals (Isack & Reyer, 1989; Wood *et al.*, 2014; Spottiswoode *et al.*, 2016). In all places where honey-hunting with honeyguides has been studied, honeyguides primarily lead humans to honeybee nests. In only a very few places, honeyguides have been reported to regularly guide to stingless bees' nests (Spottiswoode *et al.*, 2016; van der Wal *et al.*, 2022b; Kilawi, 2023). This study has highlighted northern Malawi as a third location where honeyguides reportedly assist in finding stingless bees, albeit to a lesser extent than they lead humans to honeybee nests.

In northern Malawi, honey-hunting is commonly practised while carrying out other forest activities such as herding cattle and searching for other non-timber forest products. Thus honey-hunting activity is opportunistically practised, which is what Crane (1999) previously described to be the old way of honey-hunting. This is in contrast with what happens in other places where expert honey-hunters plan specifically for honey-hunting trips (Spottiswoode *et al.*, 2016; Laltika, 2021; Kilawi, 2023; van der Wal *et al.*, 2022b). Interestingly, the minority who plan for honey-hunting trips only in around Nyika NP and Vwaza Marsh WR spend days in the forest and rely on the honeyguide to find honey. It can be suggested that honey-hunting is a beneficial forest activity to expert honey-hunters and the honeyguide is key to their success during this activity.

To engage in honey-hunting activities, people learn to use the honeyguide and locate bees' nests when they are young from their elders (parents or relatives), and sometimes peers. These findings are in line with other studies on honey-hunting cultures conducted in

eastern and southern Africa (Isack & Reyer, 1989; Kilawi, 2023; Laltika, 2021; Spottiswoode *et al.*, 2016; van der Wal *et al.*, 2022b). This suggest that honey-hunting is part of peoples traditions around Nyika NP and Vwaza Marsh WR in northern Malawi.

5.2.4 Communication between human honey-hunters and honeyguides

The current study shows that the majority of honey-hunters around Nyika NP and Vwaza Marsh WR commonly use specific whistles (on hands, or using hollow instruments) to recruit or attract the honeyguide and initiate the guiding process. Similar calls are used in eastern Africa, by the Hadzabe who use melodic whistles (Wood *et al.*, 2014). Awer and Boran honey-hunters in Kenya, use hollow instruments and clasped fist whistles (Isack & Reyer, 1989; van der Wal *et al.*, 2022b). It is possible to infer that the Ngonde people often employ a method of attracting honeyguides during their honey-hunting activities by using hollowed instruments which have been found among them since they can be heard by the honeyguide from a distatnce. Other cultural groups commonly utilised hand whistles as a means of calling the honeyguide for assistance.

Honey-hunters around Nyika NP and Vwaza Marsh WR also use coordination calls to keep track of the honeyguide and inform it is being followed, which includes mouth whistles and words of praise. Several studies involving honeyguides have reported the use of whistling sound to communicate with the honeyguide (Isack, 1999; Isack & Reyer, 1989; Laltaika, 2021; Spottiswoode *et al.*, 2016; van der Wal *et al.*, 2022b). The use of spoken words have been also recorded in Mozambique (Spottiswoode *et al.*, 2016) and Tanzania (Laltaika, 2022; Kilawi, 2023). Moreover, one honey-hunter reported making a honey badger like sound "*mhiii, mhiii*" while following the bird to the bees' nest, which

resembles grunts that are also used in Tanzania (Kilawi, 2023) and Mozambique (Spottiswoode *et al.*, 2016).

The success and sustainability of honey-hunting may depend on the specific calls used by honey-hunters during the activity. Spottiswoode *et al.* (2016) proposed that honeyguides acquire knowledge from other honeyguides near bees' nests, leading to the development of a regional cultural practise influenced by the behaviours of their human partners. Hence, it can be suggested that variations and deviations in the calls used in a given area to communicate with honeyguides (as found in this study), might decrease the efficiency of honeyguides in guiding humans to bees' nests. This is because honeyguides would need to learn the varied and/or altered calls made by humans (Spottiswoode & Wood, 2023).

5.2.5 Guiding behaviour

During the honey-hunting process, the honeyguide may lead to places with things other than wild honeybees and stingless bees' nests. Honeyguides lead humans to beehives around Nyika NP and Vwaza Marsh WR, which was also reported by Kilawi (2023) in southern Tanzania. In southern Tanzania beekeepers are guided to beehives that are ready for harvesting and locate more hives to increase yield because they own a large number of hives. Kilawi (2023) suggested that honeyguides, beekeepers, and honey-hunters could form a mutually beneficial and symbiotic three-way relationship. It remains to be investigated if this could also be the case in northern Malawi. If this is so, a possible collaboration between honey-hunters and beekeepers can be envisaged to gain access to protected areas (currently only beekeepers are allowed in protected areas).

The honeyguide does not only lead people to honeybee nests, stingless bee nests, and beehives, but also to wild animals. It has been reported that honeyguides guide humans to huge snakes, elephants, and elands. This is consistent with Friedmann (1955), who found that honeyguides can lead to lions, deadly snakes, or elephants. van der Wal *et al*. (2022b) found similar results among Awer honey-hunters in Kenya. Communities around Nyika NP and Vwaza Marsh WR believe that the bird is primarily trying to warn them of impending danger because they regard it as a good friend. When people have been led to wild animals, it is also thought to be related to the tendency of other honey-hunters not to share the contents of the bees' nest with the bird, even though some say the bird wants people to kill the animal for unknown reason.

5.2.6 Honey harvesting

Honey-hunters in the study area use some techniques to encourage the bee colonies to stay in the nests, so that more harvesting can be done at a later point in time. Many honey-hunters report using an axe to open a small hole enough to extract the wax combs from the nest, rather than cutting down the tree. After subduing the bees with fire and smoke, a common practise during honey-hunting in sub-Saharan Africa (Wood *et al.*, 2014; Laltaika, 2021; van der Wal *et al.*, 2022b; Kilawi, 2023), honey-hunters leave wax combs with brood, and/or wax to avoid bees from leaving the nest and to maintain the colony. This was also reported by Wood *et al.* (2014). When the nest is not ready for harvesting, or a honey-hunter would like to continue harvesting it in the future, a mark is used as a sign of ownership in the forest. This practise has also been reported in other cultures in Tanzania (Kilawi, 2023; Laltaika, 2021). This is sign of ownership of wild bees and this is suspected to be applied especially to nests that are large enough to produce more honey.

5.2.7 The systems of reward

Most honey-hunters interviewed in this study reward the honeyguides with wax combs filled with brood (bee larvae), sometimes honey, or leftover wax scraps. The respondents actively provide compensation to the honeyguide for their help, a finding consistent with the observations of other African researchers (Kilawi, 2023; Laltaika, 2021). Other cultural groups in some parts of Africa do not reward the honeyguide. Wood *et al.* (2014) reported that the Hadzabe culture eliminates beeswax via burning or burying. This culture believe that this method keeps honeyguides engaged, guiding them to further nests (Wood *et al.*, 2014). A few honey-hunters in this study employed a tactic of lessening the reward to incentivise the bird's ongoing guidance until the completion of honey-hunting activities on the given day, like has been reported to be done by the Awer in Kenya (van der Wal *et al.*, 2022b).

5.3 Factors influencing human-honeyguide mutualism

5.3.1 Beekeeping

Beekeeping has grown in popularity and has become the only well-known and legal method of obtaining honey around and in the reserves. The utilisation of bee products by communities in close proximity to Nyika NP and Vwaza Marsh WR dates back to time in memorial (Kaitano, 2016; McCracken, 2006). Many studies in sub-Saharan Africa show that beekeeping is being promoted to meet the world’s and the local increasing demand for honey (Gikungu, 2009; Gruber & Sanda, 2019; Kilawi, 2023; Lunyamadzo, 2016). Beekeeping have overshadowed honey-hunting in most parts of the sub-Saharan Africa (Endalamaw, 2005; Lunyamadzo, 2016; Van Blyderveen, 2022). In Malawi, beekeeping projects have received substantial funding from the government and

development agencies (Kaitano, 2016; Van Blyderveen, 2022). Thus beekeeping might be fuelling a loss in honey-hunting culture, resulting in a reduction in the supply of wild honey.

Despite the proliferation of beekeeping in the area, the continued importance of honey-hunting can be attributed to the consumer demand for naturally harvested honey primarily in marketplaces. This is consistent with the findings by Laltaika (2021) and Kilawi (2023) in northern and southern Tanzania, respectively. People place a high value on wild honey collected through honey-hunting, and continue to collect it to benefit from its therapeutic and cultural value. Wild honey produced by wild bees (both honeybees and stingless bees) is thought to contain a higher concentration of natural pollen derived from various plant sources compared to honey from hives. This appears to confer the ability to heal a variety of diseases not present in honey sourced from some conventional beehives placed in less diverse forest tree species. This suggests that honey-hunting will continue to thrive among the few individuals practising in close proximity to Nyika NP and Vwaza MarshWR in northern Malawi to continue benefiting from the therapeutic powers as also reported by Isack (1999)

5.3.2 Loss of habitat

Another challenge to honey-hunting practises is the loss of habitat. This challenge is attributed to the unsustainable utilisation of forest resources due to changes in land uses for agriculture and settlement as also reported by Gondwe *et al.* (2020). The loss of habitat was also reported in other honey-hunting communities (Kilawi, 2023; Laltaika, 2021; van der Wal *et al.*, 2022b; Wood *et al.*, 2014). Respondents in this study reported that

honeyguides were once common in communal forests, but that currently they can only reliably be found in the reserves, rather than near their homes. The decline of honey-hunting culture has been reportedly worsened by the loss of habitat for wild bees and honeyguides, as well as the alteration in weather patterns resulting from the impacts of climate change. According to Kaitano (2016), the most important factor in bee population decline is habitat loss, which is consistent with reports in the current study.

5.3.3 Less interest by youth in honey-hunting

The relatively high average age of active honey-hunters (45 years) suggests a decline in the number of youth engaged in honey-hunting, potentially leading to a decline in honey-hunting practice in northern Malawi. This is also supported when looking at the percentage of active honey-hunters interviewed that is younger than 30 years old (19%), compared to the percentage of honey-hunters interviewed over 30 years old (81%). Laltaika (2021) also found that honey-hunting is dominated by elders in northern Tanzania. In northern Malawi, it can be speculated that due to the restricted entry to Nyika NP and Vwaza Marsh WR for honey-hunting, it is difficult to use these reserves to teach the youth how to honey-hunt since honey-hunting is illegal here. In the end, children lose interest in becoming honey-hunters because the older generation struggles to find a suitable location to teach them the relevant skills. Despite that, Teel *et al.* (2010) proposed that positive human-wildlife interactions have the potential to be used effectively as a tool for successful management of protected areas. This suggests that honey-hunting can be encouraged among the youth for sustainable protected area management.

Moreover, honey-hunting is considered an old-fashioned practise by the youth, and many highly educated people have stopped honey-hunting. Some respondents stated that they used to honey-hunt before learning about modern beekeeping, but they are no longer interested. Some claimed that they could honey-hunt before going to a bigger town to finish their education. Furthermore, once they finished their education and started working, honey-hunting stopped completely. Thus, Western education has also contributed to the decline of honey-hunting culture, as it has been reported in Tanzania (Laltaika, 2021; Kilawi, 2023).

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 What is the current state of human-honeyguide mutualism in northern Malawi?

The study concludes that honey-hunting with honeyguides is active around Nyika NP and Vwaza Marsh WR. A mutualism exists between humans and honeyguides, since honeyguides help honey-hunters to locate and access bees' nests, and honeyguides benefit from the exposed beeswax. Honey-hunters use calls to attract and keep the bird informed that they are following it up until the nest is located. The researchers' experience during honey-hunting trips, during which blowing instruments were used and only very few young honey-hunters were present, gives confidence in the interview findings.

6.2 What is the future of human-honeyguide interaction in northern Malawi?

Honey-hunting surrounding Nyika NP and Vwaza Marsh WR, despite being a minority and dominated by older people, is nevertheless popular among people due to the unique therapeutic powers provided by wild bee products that beekeeping honey cannot reproduce. The practise of honey-hunting faces several threats, including beekeeping, loss of their natural habitat, restricted entry to protected areas, and loss of interest by the youth. Thus it is worthy concluding that honey-hunting around Nyika NP and Vwaza Marsh WR is at risk of declining, but that it will nevertheless likely continue to exist.

6.3 What are the safeguarding recommendations?

van der Wal *et al.* (2022a) discussed the safeguarding of human-wildlife cooperation, including human-honeyguide cooperation. The review generally describes human-wildlife cooperation faces threats from ecological and cultural changes, but also

highlights that threats need to be locally identified, to be able to plan appropriate safeguarding measures. Here, the researcher briefly shares his recommendations for safeguarding human-honeyguide mutualism around Nyika NP and Vwaza Marsh WR.

6.3.1 Protecting cultural knowledge

The study recommends that honey-hunters around Nyika NP and Vwaza Marsh WR demonstrate high levels of commitment towards their honey-hunting activities, and emphasises the need to refrain from erroneously labelling them as poachers. Honey-hunting is an integral component of their cultural heritage. Thus, there exists an opportunity to establish a legitimate framework for preserving and promoting the honey-hunting culture within the protected areas in the study area. The promotion of beekeeping within the reserve may suggest that honey-hunting can co-exist within the reserve. Overall, forest managers and other conservation decision-makers need to focus on understanding both the economic and cultural value of human-honeyguide mutualism (van der Wal *et al*., 2022a).

To address the issue of human-wildlife conflict and illegal harvesting of wild resources, fortress conservation strategies within protected areas are common practice. These methods aim to prevent animals from straying outside the reserves and discourage individuals from unlawfully exploiting natural resources. However, traditionally, people and animals have lived side by side and lived in harmony in these areas. Honey-hunting encompasses a longstanding tradition that has allowed communities to coexist harmoniously with wildlife for centuries. Thus honey-hunters should be included in and made part of biodiversity conservation in protected areas. Honey-hunters may be given

the opportunity to undergo specialised training allowing them to actively contribute towards the conservation of protected areas and help minimise illegal hunting.

6.3.2 Protecting the environment

Efforts should be made to restore and safeguard deforested areas around Nyika NP and Vwaza Marsh WR, which were previously home to honeyguides and wild bees. Ensuring a suitable environment will allow the honey-hunting tradition to continue. These forests could potentially be designated for honey-hunting. In addition, this could be combined with beekeeping to address the environmental consequences of deforestation. Furthermore, it could also attract tourists who might develop an interest in observing the honey-hunting process.

6.4 Areas for further study

The researcher has identified four key areas of research to be studied to advance the understanding of the thesis topic:

1. Assess the distribution of honeyguides and its population size across northern Malawi, and especially outside of protected areas.
2. Investigate and document existing honey-hunting cultures in other parts of Malawi.
3. Assess the social economic value of wild honey from honey-hunting obtained in wild bees' nests as compared to honey from beehives.
4. Investigate the health benefits of (wild) honey to communities, including phytochemical analysis.
5. The potential of honey-hunting as a form of ecotourism, to ultimately safeguard this precious cultural heritage.

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APPENDICES

The appendices consist of the set of interview questions used, details about data collection and a comprehensive overview of the model used, along with the resulting outputs.

Appendix 1: Interview questions

GENERAL

What is your current age?

What cultural group do you belong to?

What have you done in the last 12 months to make money?

SECTION A: Honey use

Do you use honeybee honey? If yes, what do you use honeybee honey for?

What is the market price for honeybee honey in your village?

Do you use stingless bee honey? What is the name of the stingless bees in your local language?

If yes, what do you use stingless bee honey for?

What is the market price for stingless bee honey in your village?

Do you know the bird that guides people to honeybees' nests?

[Research participants are presented with three photographs showing an adult greater honeyguide, a juvenile greater honeyguide and a woodpecker] What can you tell me about these birds? In case honeyguide(s) are accurately identified: Does this bird have a cultural significance, or are there specific stories known about the bird?

What is the name of this bird in your language?

Has this bird ever tried to guide you?

SECTION B (for honey-hunters)

Do you go on trips only for honey-hunting, or do you mainly honey-hunt opportunistically while busy with other activities like herding cattle? (can be both)

How important is selling honey for you as a source of income in the honey-hunting high season?

Do you use honey for bartering? If so, what goods do you exchange it for?

From who did you learn to honey-hunt?

When was the first time you went on a honey-hunt?

When was the last time you went on a honey-hunt?

How often (per month) do you go honey-hunting in the honey-hunting high season?

Do you routinely go on honey-hunts by yourself, or with friends and/or family? If in a group, is group mostly the same or does it differ?

When you harvest a wild bees' nest, what do you take out from the bees' nest?

Do you honey-hunt more in some years when crops have failed?

When you are out honey-hunting, do you make use of the bird to find bees' nests?

If so, how often does a honeyguide help you to find bees' nests for harvesting?

B2: REWARDING OF THE HONEYGUIDE

Do you ever leave things for the bird to eat after being guided to a bees' nest? If Yes, why?

If Yes: How much and what? Wax combs or just scraps/spit-out bits of wax? Do you do anything special with what you leave behind?

In case they say rewarding if necessary: what happens if/when you do not reward the honeyguide with wax?

B3: HONEY-HUNTING SIGNALS

Do you use sounds to communicate with the honeyguide?

Is this a specific and consistent sound(s) (e.g. particular melody) or is it a generic sound (e.g. any whistle or loud noise works)?

If specific sound, what kind of sound?

From whom did you learn this sound to communicate with the bird?

B4: OTHER HONEYGUIDE BEHAVIOUR

Have you ever been guided to anything else besides bees? If yes, what and how often?

Why do you think the honeyguide guided you to these things, rather than you just coincidentally encountering them, while looking for the bees' nest?

Have you ever been guided to a man-made beehive?

Have you ever guided by a honeyguide to a nest of a stingless bee?

When a bird guides you to a stingless bees' nest, do you usually harvest the nest?

B5: HONEY-HUNTING SUSTAINABILITY

What means to subdue bees (to prevent stinging) do you use?

When you harvest a nest, do you do anything to encourage the bees to return to it? (multiple answers possible)

What tools do you use to harvest them?

Is there any way you can prevent someone else from harvesting that nest?

B6: TREND OF MUTUAL INTERACTION IN FUTURE

Has the practise of honey-hunting in general changed since you were young?

Has in particular the role of honeyguides in honey-hunting changed over time?

Do you think the interaction between people and honeyguides will exist in the future?

How do you see the interaction between people and honeyguides changing in future generations?

Appendix 2: Informed consent form

Mzuzu University Research Ethics Committee (MZUNIREC)

Informed Consent Form for Research in Honey-hunting with honeyguides

Introduction

I am **George Malembo M'manga** from **Mzuzu University**. I am doing research on **Honeyguides, Honey-Hunting and the Current State of Human-Honeyguide Mutualism in Northern Malawi.** This consent form may contain words that you do not understand. Please ask me to stop as we go through the information and I will take time to explain. If you have questions later, you can ask them of me or of another researcher.

Purpose of the research

This research aims to **document the remaining honey-hunting culture in the northern region of Malawi**.

Type of Research Intervention

This research will involve your participation in a group discussion and/or individual interview.

Participant Selection

You are being invited to take part in this research because **the researcher is a student who is expecting to learn more from you and eventually document the honey-hunting culture in Northern Malawi. Voluntary Participation**

Your participation in this research is entirely voluntary. It is your choice whether to participate or not. If you choose not to participate nothing will change. You may skip any question and move on to the next question.

Duration

The research takes place for a period of **four months**.

Risks

You do not have to answer any question or take part in the discussion/interview/survey if you feel the question(s) are too personal or if talking about them makes you

uncomfortable.

Reimbursements

You will not be provided any incentive to take part in the research.

Sharing the Results

The knowledge that we get from this research will be shared with you and your community before it is made widely available to the public. Following, we will publish the results so other interested people may learn from the research.

Who to Contact?

If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact: **Mr George Malembo M'managa**, Mzuzu University, P.O. Box 201 Mzuzu. +265881041732/+265992729260

This proposal has been reviewed and approved by Mzuzu University Research Ethics Committee (MZUNIREC) which is a committee whose task it is to make sure that research participants are protected from harm. If you wish to find more about the Committee, contact Mr. Gift Mbwele, Mzuzu University Research Ethics (MZUNIREC) Administrator, Mzuzu University, P/Bag 201, Luwinga, Mzuzu 2, Phone: 0999404008/0888641486

Do you have any questions?

Part II: Certificate of Consent

I have been invited to participate in research about **Honeyguides, Honey-Hunting and the Current State of Human-Honeyguide Mutualism in Northern Malawi.**

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study

Print Name of Participant_____

Signature of Participant _____

Date _____

Day/month/year

If illiterate [1]

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of witness_____ **Thumb print of part**

Signature of witness _____

Date _____

Day/month/year

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands the research project. I confirm the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Signature of Researcher /person taking the consent_____

Date _____

Day/month/year

[1] A literate witness must sign (if possible, this person should be selected by the participant and should have no connection to the research team). Participants who are illiterate should include their thumb print as well.

Appendix 3: Bird pictures presented to respondents when asked about their familiarity with the bird that guides to bees' nests, and pictures of a honey badger.

ADULT MALE GREATER HONEYGUIDE

JUVENILE GREATER HONEYGUIDE

HONEY BADGER

GOLDEN TAILED WOODPECKER

Appendix 4: Normality test and statistical model outputs

Generalized linear mixed model (GLMM)

The R code was used to conduct a Generalized Linear Mixed Model (GLMM)analysis in order to assess if there are any significant differences in the reported litre price among honey-hunters, beekeepers, and individuals engaged in both honey-hunting and beekeeping.

```
model <-lme4::lmer(formula = Price_per_litre ~ as.factor(Occupation1) + (1|Village), data = L)
hist(re0
sid(model))
qqnorm(resid(model))
summary(model)
car::Anova(model, type=3)
emmeans(model, list(pairwise ~ Occupation1), adjust = "tukey")
```

Normality test output

Figure S1 A, B, C, and D depict the anticipated normality and homogeneity conditions for Generalized Linear Mixed Models (GLMMs) utilising residuals (A and C) and normal probability plots (B and D) with respect to the reported price of honeybee (A and B) and stingless bee (C and D) honey.

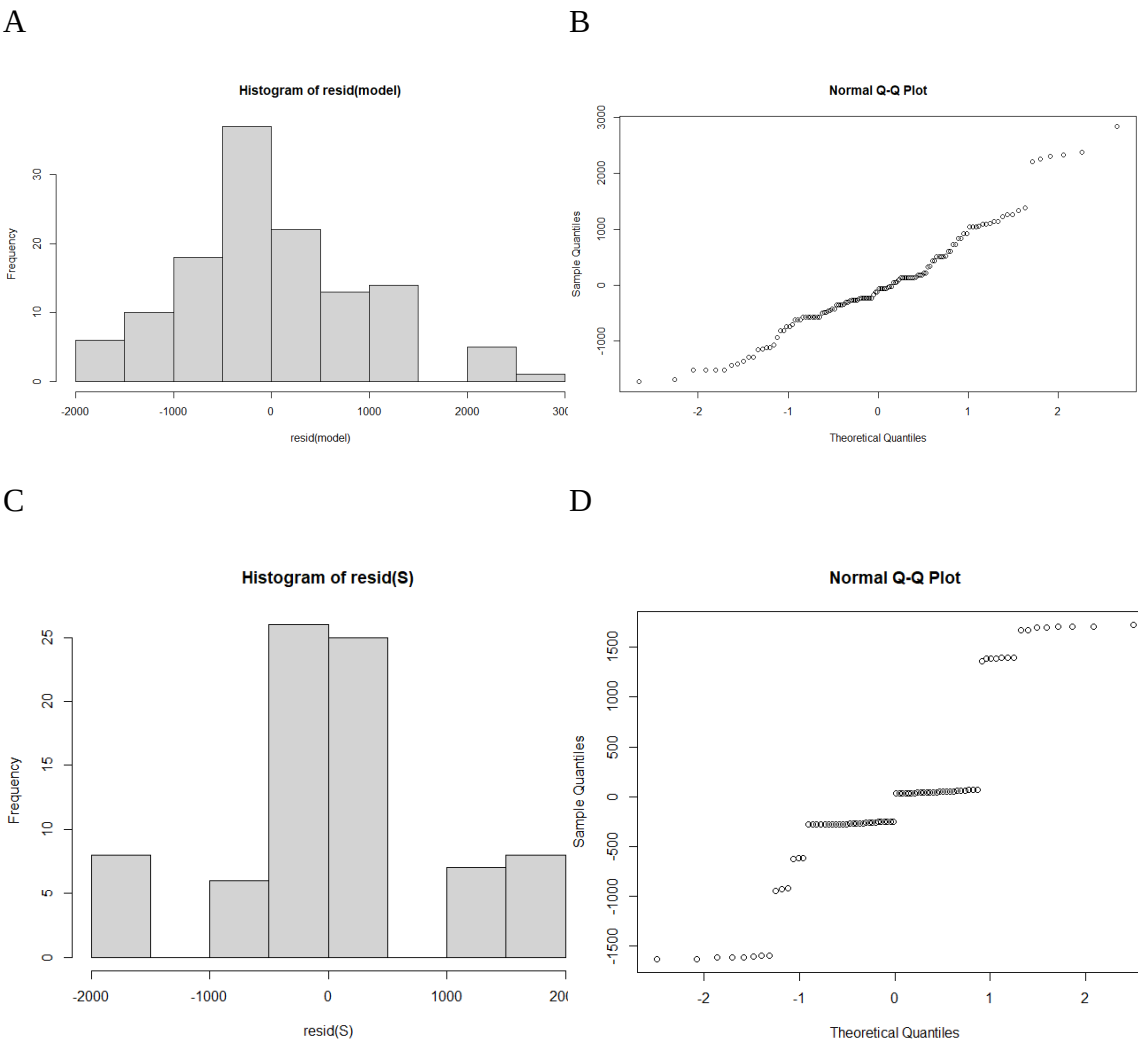

Figure S1 A and C show histograms of residuals used to evaluate the normality and homogeneity of the data for the price of honey made by honeybees and stingless bees, respectively. Quantile-quantile plots, namely Figure S1 C and D, were employed to visually assess the normality and homogeneity of the data for both honeybee honey and stingless bee honey prices.

Statistical Model outputs

The statistical output derived from the assessment of honeybee (A) and stingless bee (B) honey prices.

(A)

Analysis of Deviance Table (Type III Wald chi-square tests)
Response: Price per litre

	Chisq	Df	Pr(>Chisq)
(Intercept)	*596.208*		*1 < 0.00000000000000022 ****
(Occupation1)	*14.212*	*2*	*0.0008201 ****

*Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Occupation1	emmean	SE	df	lower.CL	upper.CL
0	3704	154	35.0	3392	4017
1	5295	421	99.2	4459	6131
2	3924	175	38.8	3569	4279

Degrees-of-freedom method: kenward-roger
Confidence level used: 0.95

pairwise differences of Occupation11	estimate	SE	df	t.ratio	p.value
Occupation10 - Occupation11	-1591	434	114	-3.665	0.0011
Occupation10 - Occupation12	-220	202	119	-1.090	0.5220
Occupation11 - Occupation12	1371	437	118	3.138	0.0061

Degrees-of-freedom method: kenward-roger
P value adjustment: tukey method for comparing a family of 3 estimates

(B)

Analysis of Deviance Table (Type III Wald chisquare tests)

Response: Price per litre

	Chisq	Df	Pr(>Chisq)
(Intercept)	*570.9032*	*1*	*<2e-16 ****
(Occupation1)	*2.3401*	*1*	*0.1261*

*Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*