Review of Regional Research
https://doi.org/10.1007/s10037-025-00230-6

ORIGINAL PAPER

Elephant corridors in the Kavango-Zambezi transfrontier conservation area (KAZA TFCA): environmental infrastructures for a greener anthropocene in Namibia's Mudumu landscape

Emilie Köhler[1] · **Michael Bollig**[2]

Accepted: 21 January 2025

Abstract Wildlife corridors are seen as essential environmental infrastructure guaranteeing species connectivity and biological diversity in contemporary conservation landscapes. Harking back to recent social science literature on infrastructure in general and environmental infrastructure in particular this contribution will analyze one contested wildlife corridor as part of a large conservationist project, the giant Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA), founded in 2011, and with 520,000 km^2 the world's largest conservation area. Using elephant corridors as an example, we will examine how they come into being and how they are governed. Only at first sight wildlife corridors appear as something entirely natural, constituted by the daily or seasonal movements of large herbivores. Indeed, elephants for example, produce paths through the savannah that are well visible in the landscape. But to make them wildlife corridors in conservation projects human action is needed: we will analyse wildlife corridors as hybrids of wildlife produced paths, administrative action and modern technologies of wildlife monitoring. As we will show in some detail focusing on one important Namibian wildlife corridor, the so-called Sobbe corridor, the human-elephant conflict is a real challenge leading to local resistance to corridors. Surprisingly, though, conflict is more frequent along the linear settlements close to roads, than on wildlife corridors, instances of human-elephant conflict is a prominent topic linked to corridors. The most significant challenge to corridors though comes from the rapid expansion of agricultural fields as well as from local conflicts over land ownership.

✉ Emilie Köhler
emilie.koehler@uni-koeln.de

Michael Bollig
michael.bollig@uni-koeln.de

[1] Institute of Social and Cultural Anthropology, University of Cologne, Cologne, Germany

[2] Institue of Social and Cultural Anthropology, University of Cologne, Cologne, Germany

Published online: 05 March 2025

Keywords Connectivity · Wildlife corridors · Elephants · Conservation · Infrastructure · Coexistence

Zusammenfassung Wildtierkorridore gelten als wesentliche Umweltinfrastrukturen, die die Konnektivität zwischen Lebensräumen und die biologische Vielfalt in modernen Naturschutzlandschaften gewährleisten. Mit Bezug auf sozialwissenschaftliche Literatur über Infrastruktur im Allgemeinen und Umweltinfrastruktur im Besonderen, wird in diesem Beitrag ein umstrittener Wildtierkorridor als Teil eines großen Naturschutzprojekts analysiert, die Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA), die mit 520.000 km² das größte Schutzgebiet der Welt ist. Am Beispiel von Elefanten gehen wir der Frage nach, wie Wildtierkorridore entstehen und wie sie verwaltet werden. Nur auf den ersten Blick erscheinen sie als etwas Natürliches, das durch die täglichen oder saisonalen Bewegungen großer Pflanzenfresser entsteht. In der Tat entstehen durch regelmäßige Wanderungen, von beispielsweise Elefanten, gut sichtbare Wege in der Savannenlandschaft. Um sie zu Wildtierkorridoren zu machen, ist jedoch menschliches Handeln erforderlich: Wir betrachten Wildtierkorridore als hybride Elemente, die durch Tiermobilität, Verwaltungsmaßnahmen und moderne Technologien geschaffen werden. Wie wir am Beispiel eines wichtigen namibischen Wildtierkorridors, dem so genannten Sobbe-Korridor, im Detail zeigen werden, ist der Konflikt zwischen Mensch und Elefant eine echte Herausforderung, die zu lokalem Widerstand gegen die Korridore führt. Überraschenderweise sind Konflikte entlang der linearen Siedlungen an Straßen häufiger als in den Wildtierkorridoren, obwohl Konflikte zwischen Menschen und Elefanten ein wichtiges Thema im Zusammenhang mit den Korridoren bleiben. Die größte Herausforderung für die Korridore geht jedoch von der raschen Ausdehnung der landwirtschaftlichen Nutzflächen sowie von lokalen Konflikten um Landbesitz aus.

1 Introduction

The Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA), founded in 2011, and covering approximately 520,000 km², is the world's largest conservation area, and stands as one of the most ambitious conservation initiatives globally (Dittmann 2024; Kalvelage et al. 2020). Established in 2011 by the five southern African nations Angola, Botswana, Namibia, Zambia and Zimbabwe, KAZA aims to promote the conservation of natural heritage, economic development, solidarity, peace and security, and the sustainable use of ecosystems by aligning and harmonising policies and practices across its member states. Spanning a vast landscape that includes the vital Kavango and Zambezi river systems, KAZA supports an array of ecosystems, including Botswana's renowned Okavango Delta and Zimbabwe's Victoria Falls, two world heritage sites much frequented by international visitors. By promoting its rich biodiversity for international tourists, KAZA aims to enhance regional value chains through the involvement of local communities and entrepreneurs in conservation planning and management (Mlilo et al. 2024). Around three million people share the land with an extraordinary diversity of wildlife, including the

world's largest contiguous population of African elephants (*Loxodonta africana*), estimated at 230,000 individuals (Bussière and Potgieter 2023).

Elephants are KAZA's flagship species, and are highly valued for their affective capacities, as an economic resource for trophy hunting and photographic tourism, and as umbrella species whose conservation benefits numerous other species. Elephants are wide-ranging animals, which require space beyond protected areas for their movements (Huang et al. 2022; Brennan et al. 2020). In stark contrast to the overall continental elephant herd (Skinner 2014), their numbers are steadily growing in areas such as northern Botswana, north-eastern Namibia and western Zimbabwe, which endangers regional biodiversity and local communities (Tickle et al. 2024; Buchholtz et al. 2023). Additionally, wildlife movement in general, and pathways for seasonal elephant migrations in particular, are increasingly disrupted by landscape fragmentation. Human-made infrastructures such as roads, veterinary fences, and expanding settlements pose significant barriers to the mobility of migrating species (Brennan et al. 2020; Naidoo et al. 2022).

To preserve biodiversity and essential ecological processes such as seed dispersal, migration and genetic exchange, large scale conservation areas increasingly work towards the maintenance and restoration of landscape connectivity and approach wildlife as metapopulations (van Aarde and Jackson 2007; Hanks 2003). Key to this target are wildlife corridors, "linear landscape elements that connect two or more patches of natural habitat and function to facilitate movement" (Hilty et al. 2006: 90). The *Strategic Planning Framework for the Conservation and Management of Elephants* which was adopted by the member states in 2019, underscored these efforts. The five nations agreed to integrate elephant mobilities into large-scale land use planning, to manage the population as one contiguous population, to gain and share more data about their movements, distributions, numbers and poaching incidents, and to promote human-elephant coexistence (KAZA TFCA Secretariat 2019). Major investments have been made to achieve these goals and to identify elephant populations and their mobility patterns. During the first coordinated KAZA Elephant Aerial Survey in 2022, elephants were counted within the boundaries of KAZA, and data from 291 collared elephants from 2010 to 2023 was analysed in a *KAZA Policy Brief for Elephant Movements* (KAZA Elephant Sub Working Group 2023). The acquired data informs elephant management strategies such as hunting quotas, land use planning or human-elephant conflict mitigation strategies and is essential to map and safeguard wildlife corridors. Nowadays, technologies such as GPS trackers, smartphones, and camera traps have become increasingly central to the definition, monitoring and management of such corridors, shaping the strategies and policies at both national and international levels. The implementation of these corridors varies across the countries, with different levels of government involvement and diverse approaches by NGOs, which often combine community engagement with conservation science.

Namibia's Zambezi Region lies at the centre of KAZA and is therefore essential for landscape connectivity. There, wildlife corridors run through communal lands and are integrated into the zonation plans of conservancies (Bollig 2024; Dittmann 2024). Their promotion is embedded in the logic of Namibia's wildlife economy, which has a utilitarian approach to wildlife and aims to combine conservation goals

with rural development (Revilla Diez et al. 2023). The establishment of wildlife corridors in local communities, however, is not free of contestation as the process creates new orders of social, economic and conservation values which are conflicting with other interests.

In this paper, we inquire how wildlife corridors come into being and how they are governed. Only at first sight wildlife corridors appear as something entirely natural, as infrastructural hallmarks of pristine wilderness, constituted by the daily or seasonal movements of large herbivores. Indeed, elephants for example, produce paths through the savannah landscape that are well visible in the landscape. But to make them wildlife corridors in conservation projects human action is needed: We analyse wildlife corridors as hybrids of wildlife produced paths, administrative action and modern technologies of wildlife monitoring. At the local level, community-based organisations, like the Namibian conservancies or the Botswanan community trusts, provide zonation plans that mark corridors. Together with the regional administration, conservation-oriented NGOs and donors they define corridors. Often the definition of what is an important corridor is impacted by local politics as much as by globally circulated ideas on the function and structure of corridors and their desirable layout. Community based conservation organisations habitually devise a number of rules to keep such corridors free from human settlements and human land use and they patrol such corridors to curb poaching and unwanted trespassing. In the following section, we first introduce our conceptual framework, environmental infrastructures, which allows us to analyse wildlife corridors as a human and more-than-human co-production, involving technologies but also practices and political decision making. Second, we provide an overview of how elephant corridors are established in the Mudumu landscape through elephant movements, but also through political and administrative processes. Third, we present our methodology and, fourth, we turn to our case study, the Sobbe wildlife corridor. Based on this case we discuss the intended, tolerated and unintended consequences that have resulted from the infrastructuring of the wildlife corridor in the Sobbe conservancy. Lastly, we summarise our findings in the conclusion.

2 Environmental infrastructure as a conceptual framework

Drawing on Blok et al. (2016), we examine the establishment and maintenance of wildlife corridors as an infrastructuring of the environment, where environmental and information infrastructures converge and thereby create new values, social orders and practices (see Bowker and Star 1999 for information infrastructure; Bollig and Krause 2023 for environmental infrastructure). Information infrastructure refers to complex, evolving systems that integrate information artifacts—such as tools, devices, or systems for storing, tracking, displaying, or retrieving information—with organised practices, forming a whole that supports various social and technical processes (Star et al. 2003). In large-scale information infrastructure "standards, categories, technologies, and phenomenology are increasingly converging" (Bowker and Star 1999, p. 47). However, as Bowker and Star continue, this convergence poses political and ethical questions which are often obscured in infrastructure. Informa-

tion infrastructures change the patterns of work practices, facilitate coordination, stabilise ways of knowing and classifications and eventually change social organisation, value systems and moral orders (ibid.). Blok et al. (2016) introduced the notion "infrastructuring environments", which explores the "contested landscapes of technology, knowledge, processes, and effects." This approach examines how the environment is managed and understood through various material and conceptual means, and the impacts of these practices (Blok et al. 2016, p. 3). The notion of *infrastructuring* emphasises that infrastructures are not static but are constantly "in the making" (Niewöhner 2015). While Blok et al. recognise that the natural environment is not merely a passive recipient of infrastructuring efforts, their approach still tends to prioritise human actions and ways of knowing, often overlooking the agency of more-than-human actors.

Environmental anthropologists have dealt with environmental infrastructures as emerging from cooperative interaction between humans and non-human actors. Historian Kreike (2013) used the concepts of "environmental infrastructure" and "environing" in his study of an intensely used north-central Namibian agroforestry landscape. Kreike sees environmental infrastructure as being conditioned by "both Nature's and Culture's creativity" (Kreike 2013, p. 1). The making of environmental infrastructure, Kreike terms *environing* (ibid. 24). Krieg and others (Krieg et al. 2020) argue that we are witnessing "an infrastructuring of non-human worlds", i.e. non-human worlds are put to use by humans to fulfil specific functions and benefit certain people, and we may well argue that wildlife corridors are a humanly devised strategy to help people and elephants to profit from the isolation of some wildlife paths from a meshwork of paths. In recent years, environmental anthropologists have also focussed on the emergence of environmental infrastructure through cooperative interaction between humans and non-human actors.

Following Hodgetts and Lorimer (2020), we focus on "elephant mobilities" rather than simply "movements," emphasising that animal movements are deeply embedded in power relations, human actions, and infrastructure and are not just changes in spatial coordinates. With Blok et al. (2016) who stipulated that "attending to how environments get infrastructured means attending to contested landscapes of technology, knowledge, processes, and effects. It involves attending to how 'the environment' is managed and known, through what material and conceptual means, and to what effects" we put forward three key questions: How are wildlife corridors in northeastern Namibia's Mudumu landscape becoming infrastructure? What makes such wildlife corridors vulnerable and what contributes to their resilience? And finally: How can corridors be governed in an environmentally just way, so that benefits and damages are equally distributed, prior rights in these landscape elements are acknowledged and rural dwellers are allowed to participate in decision making?

In the following section, we provide background information on how elephant corridors are established in the Mudumu landscape, before turning to our methodology and then to our case study.

3 Establishing corridors in the Mudumu landscape

3.1 Elephant mobilites

To understand corridor planning, we need to understand how and why elephants move at all. Purdon et al. (2018) describe elephants as "facultative partially migratory species" since they don't migrate annually but mainly in response to seasonal changes in their environment. Elephants generally seek greener vegetation throughout the year (Loarie et al. 2009). However, migrations are also based on individual decisions. Elephants migrate for social reasons, to avoid conflicts or to find mating partners (Purdon et al. 2018). Due to their well-developed olfactory bulb and large temporal lobe, scientists assume that elephants derive most information from scent and sound (Garstang 2015). Elephants are able to detect infrasound and seismic cues, which allows them to communicate over wide distances, to warn each other from dangers and to avoid competition over food and water sources (O'Connell-Rodwell 2007). On movement corridors, elephants can read olfactory cues of their conspecifics, they recognise individuals and track their locations (Bates et al. 2008). Moreover, olfactory cues are used to find water or preferred food sources (Schmitt et al. 2018). Elephants are even able to find natural and artificial water sources, to determine sugar levels in fruits (Nevo et al. 2020) or food quantities based on smell (Plotnik et al. 2019; Wood et al. 2022). However, elephants also use a broad variety of gestures and body language to communicate which shows the importance of visual senses in elephant cognition (Bates 2018). Additionally, their long-term memory skills help them to navigate through the landscape. Family herds are led by matriarchs who have a precise spatial memory allowing them to find water sources in times of drought (Polansky et al. 2015), but also the carcasses of lost relatives which elephants have been observed to revisit (Goldenberg and Wittemyer 2020). Elephants' long lifespan, their high intelligence, sociality and individuality makes it difficult to generalise elephant movements but also an enriching field of study.

Elephant movements leave a pattern on the ground testifying to prior generations of elephants' mobility behaviour. The animals have changed the earth and vegetation on sandy paths of the Mudumu landscape profoundly.

Zoologist Garstang, reporting on elephant corridors more generally, noted that "the surface of these trails is often a mixture of sand and fiber from centuries of droppings, producing a soft, spongy surface that can be trodden in silence" (Garstang 2015, p. 10). Moreover, elephants' excellent spatial memory enables them to navigate a complex network of paths in a directed way. An informant in Kwandu conservancy explained: "That is why we see corridors, these corridors have been made by ancestral elephants, they used them again and again; as long as a family does not get finished, this knowledge about the corridor (*ndjira ye zipau*) is carried on to other elephants" (Interview Kwandu Conservancy, September 2023). Local informants suggest that the transgenerational transmission of information, along with communication among conspecifics, may be as instrumental as visual or olfactory information in maintaining these ancient routes. In the early 20th century Shortridge (1934) noted that where elephants were present, their trails were clearly visible in the landscape and used by wildlife and people. He described elephant migrations from

Angola into Namibia and elephants spending time along the Chobe and Zambezi River in the dry season and dispersing in the surrounding areas during the rains. Based on aerial surveys that were conducted between 1980 and 1990 in what was then the Caprivi Region[1], Rodwell (1995) described a shift in elephant ranges. Until 1988 elephants remained mainly in the state forest during the dry season, but then increased considerably in the Kwando region, in what is now Bwabwata and Mudumu National Parks. However, besides anecdotal accounts of former elephant ranges, it is difficult to reconstruct their ancient routes.

In a rapidly changing landscape where elephant habitats are shrinking and well-known places are not accessible anymore, elephants learn to adapt to human expansion. In northern Botswana Buchholtz et al. (2021) found that elephants more frequently accessed water sources at night in areas with more human activity. The assumption that elephants try to avoid humans was confirmed in other studies which examined their movements in anthropogenic landscapes (see for example Gaynor et al. 2018; Gaynor 2019). Adams et al. (2022) further showed that corridors close to fields or gardens were mainly used at night, which might also be connected to crop-raiding behaviour. Similarly, Tiller et al. (2024) suggested that elephant corridors near farmlands play an important role in human-elephant conflict as they are used by elephants to access farms.

3.2 Political and administrative process of establishing corridors

At first glance, wildlife corridors may appear to be natural pathways, formed by the daily or seasonal movements of large herbivores. Elephants produce paths through the savannah landscape that are also used by other herbivores and carnivores and also often by cattle. These paths are well visible in the landscape. However, the routes are not static and nowadays the creation and maintenance of functional wildlife corridors involves international, national and local cooperation, strategic land use planning and vast amounts of data, which is collected with the help of satellites, helicopters, airplanes, smart phones camera traps, foot patrols and the animals themselves.

From 1999 to 2005, Namibia's Ministry of Land Reform developed regional land-use plans for eight of the country's 13 regions to address the lack of comprehensive spatial planning (Scheffler 2016). For Namibia's Zambezi Region, the first *Baseline Report for the Zambezi Integrated Regional Land-use Plan* (IRLUP) was published in March 2015, and introduced wildlife corridors as important elements for the growth of wildlife conservation and tourism (MLR and Ministry of Lands and Resettlement 2015a). With the help of communities and stakeholder meetings the main wildlife corridors of the Zambezi region were identified and published in the second volume of the IRLUP (MLR and Ministry of Lands and Resettlement 2015b, see Fig. 1). The corridors were identified in a number of meetings, with workshops taking place in Windhoek, Katima Mulilo and in respective constituencies in the region throughout the year 2014. Especially in the workshops on the community level various land-use practices were discussed and local knowledge of wildlife mobility was gathered

[1] In 2013, the Caprivi Strip or Caprivi Region was renamed the Zambezi Region due to the colonial legacy of its former name.

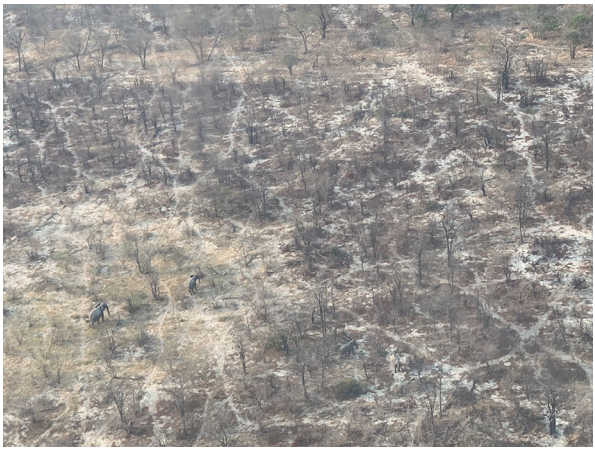

Fig. 1 Elephant paths from bird's eye view, photo taken by Emilie Köhler

systematically, and corridors were identified by oral accounts and in situ visits to such sites. The search for corridors was enhanced by GIS capacity. Community game guards patrolled along such corridors and entered GPS points into their smartphones wherever they found wildlife or saw spoors of wildlife. Hence, the corridors that were finally put on the map were deduced from diverse data sets and ample oral information of locals (oral information V. Schiller, GIZ advisor to the compilation of the Zambezi Integrated Land Use Plan). The wildlife corridors depicted in the land use plan have a distinct ecological goal: they facilitate the passage of wildlife across the region.

Most designated wildlife corridors in the Zambezi Region are on customary land and do not fall under the category of protected areas (Fig. 2). Traditional authorities have the power to allocate customary land to members of their community for farming or settlements. Sometimes members also claim ancestral land in the corridors which was used by their forefathers. Traditional authorities play an important role in the definition of community-based conservation areas and the zonation of conservancies, or in the preservation of corridors. They usually get a share of the benefits that are derived from those areas (Mosimane et al. 2023).

Lastly, the land use plan emphasises that the corridors have another function. The Mudumu landscape is not only a major transit zone for wildlife but is also visited by a large number of tourists every year. There is a number of hotels and camping grounds in the proximity of the corridors. In this way wildlife corridors ensure ecological connectivity but also enduring attractivity of the landscape to tourists who cherish the proximity of wildlife (Kalvelage et al. 2021).

The corridors were further refined in 2019 when the MEFT specifically mapped elephant corridors by combining locally identified corridors with elephant movement data (MEFT 2021a). The results were integrated into the *Wildlife Corridor Strategy of the Zambezi Region* (MEFT 2021b), which is to date the first and only wildlife corridor policy paper in KAZA and therefore in many ways has a piloting character.

The identification and monitoring of corridors has involved technology since the 1990s. In the Zambezi region, satellite collars were first used to track elephant

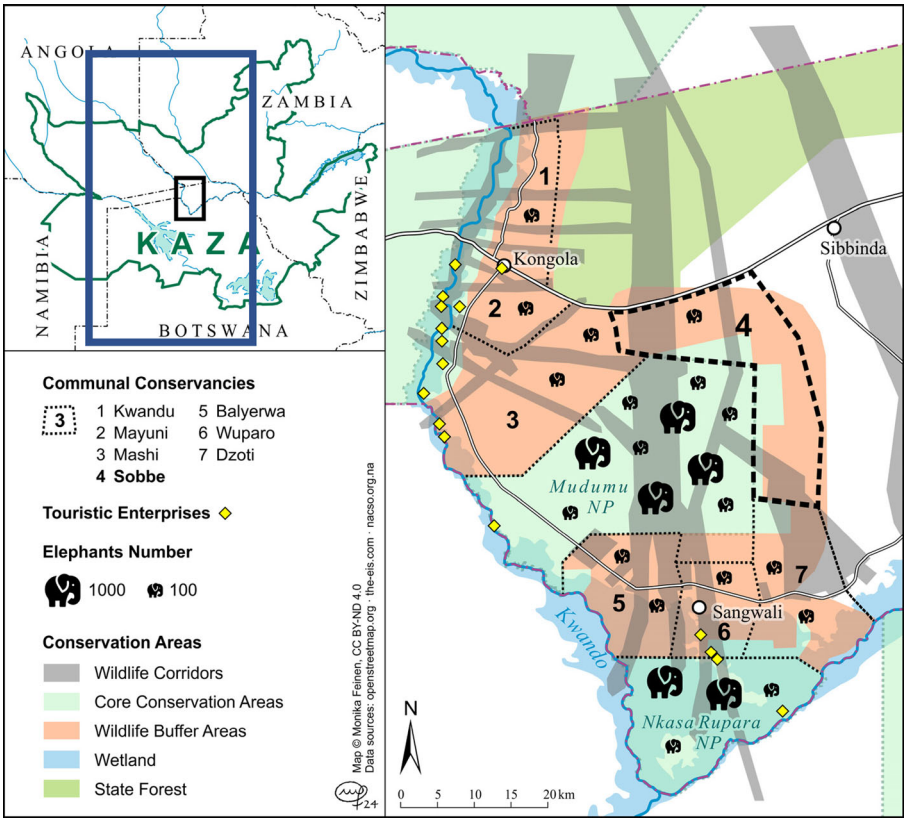

Fig. 2 Conservation areas, wildlife corridors and elephant densities in the Mudumu landscape

movements and identify migration routes in 1993–1995 (Rodwell 1995). These early efforts, though limited by the technology of the time which only transmitted data once in a week, indicated cross-border movements of elephants into Botswana, Zambia and Angola. The erection of an electrified veterinary fence by the Government of Botswana in 1996–1997 along the shared border of Botswana and Namibia blocked movements of female elephants and other wildlife (Brennan et al. 2020). It is assumed that females do not cross the fence because they move in breeding herds with young elephants (Interview, 17.08.2023). After some negotiations between the two states a 30 km long gap was reopened in 2001 at the Kwando River where wildlife could move into Bwabwata National Park (Naidoo et al. 2022). Additionally, the MEFT started to conduct annual corridor surveys of the Eastern Zambezi Region in 2021, where transects along the four main corridors (Sobbe, East Zambezi, Mudumu/Nkasa Rupara and Lake Liambezi) are flown with a helicopter and map the presence of settlements, crop fields, infrastructure, livestock and wildlife with accurate GPS locations (Interview, MEFT, 28.04.2023). In 2021, they found nine elephants and one spotted hyena (*Crocuta crocuta*) in the Sobbe wildlife corridor, which confirmed its importance for elephant movements. The surveys were

financed by the WWF Namibia and intended to help determine whether corridors are still viable and should be demarcated as official wildlife passages. However, the demarcation of official wildlife corridors is controversial and wildlife corridors don't have the legal status of protected areas in Namibia. Therefore, different people and administrative steps are involved in securing wildlife corridors.

4 Methodology

This contribution is grounded in ethnographic fieldwork that was carried out between 2018 and 2024 in the western Zambezi Region, often addressed as Mudumu landscape after a small national park in the area. Each author independently conducted research in adjacent field sites. In Sobbe Conservancy research was carried out from January 2023 to April 2023, in neighbouring Mashi conservancy from 2018 to 2024. Research we present here, assessed opinions, knowledge and practices surrounding the Sobbe wildlife corridor and entailed ethnographic interviews with key informants such as conservancy members, game guards and committee members of Sobbe and Mashi conservancy, the *Ministry of Environment, Forestry and Tourism* (MEFT), local inhabitants farming and residing near the corridor, local politicians, traditional authorities as well as NGO staff of the *Namibia Nature Foundation* (NNF), *Integrated Rural Development and Nature Conservation* (IRDNC) and the *World Wide Fund for Nature* (WWF). Ethnographic interviews include both proper interviews along fixed schedules but also encompass friendly conversations. They are habitually not aligned to a strict questionnaire but give priority to the pace, interest and knowledge of the interviewee (Spradley 2016). In total, about 30 in-depth semi-structured interviews were conducted. Additionally, one focus group discussion was held in Lubuta, which belongs to Mashi conservancy. Eight languages (SiSubia, SiYeyi, SiFwe, SiTotela, SiMbukushu, Barakwena, SiMbalangwe and SiLozi) are spoken in the Zambezi Region (Harris 2018). In rural areas, where English is less common, both authors worked with research assistants. All interviews were recorded with an audio recorder or through detailed fieldnotes and transcribed afterwards. Besides interviews, participant observation was crucial to understand the practices surrounding the corridor. Participant observation was involved to join the game guards on foot patrols, attending conservancy meetings, accompanying NGOs and doing walks with farmers in their fields and in the corridor.

The research was further complemented by incorporating perspectives of national and international conservation stakeholders and implementors, who have received less attention in the study of wildlife corridors, but are crucial to understand unintended consequences (Green and Sandbrook 2021). Stakeholders, such as wildlife corridor coordinators, members of the KAZA Secretariat, consultants and key informants from the MEFT were interviewed in Katima Mulilo, the capital of the Zambezi Region, Namibia's capital city Windhoek, as well as in Kasane, Botswana. The interviews focused on the intentions, planning and implementation of wildlife corridors in local communities.

Policy documents and reports such as the *National Elephant Management Plans* of Namibia (see for example Ministry of Environment and Forestry and Tourism

2020), the *Zambezi Wildlife Corridor Strategy* (MEFT 2021b), the *Strategic Planning Framework for the Conservation and Management of Elephants in KAZA TFCA*, the *KAZA Policy Brief on Elephant Movements and Connectivity* (KAZA Elephant Sub Working Group 2023; KAZA TFCA Secretariat 2019), the Namibian Community Conservation Reports (MEFT and NACSO 2023; 2022) and Conservancy Reports (see for example NACSO 2022) present different politics and strategies how to establish, implement and safeguard corridors. We are thankful to NACSO and WWF for sharing a huge data set on human-wildlife conflict. The data covers all instances of human-wildlife conflict in the region between 2004 and 2020. Insights from document analysis and the analysis of large data sets on human-wildlife conflict served as a basis for interviews to find out what was happening beyond the corridors "on paper" and to get a better quantitative grasp of human-wildlife interaction along and within corridors.

Lastly, as Barua (2021) and Krieg et al. (2020) stress, a non-anthropocentric exploration of infrastructures includes a broadening of disciplinary boundaries and makes it necessary to draw on insights from ecology and ethology to understand more-than-human practices. This goes in line with Hodgetts and Lorimer's understanding of animals' mobilities, which is distinct from animal mobilities, and further emphasises the importance of understanding how these movements are experienced by the animals themselves. This perspective is crucial for recognising the lived experiences and embodied patterns of animals within anthropogenic landscapes in general and within corridors in particular. It also highlights the need for interdisciplinary research methods that incorporate ethnographic insights, ecological data, and critical phenomenological approaches to capture the experiences of animals (Hodgetts and Lorimer 2020). Hence, besides observations and interviews on elephant behaviour and movement ecology, we incorporated literature of the natural sciences to expand our knowledge on elephant mobilities, their ways of sensing the world and experiences. In the following section, we will trace the infrastructuring of a prominent elephant corridor in KAZA, the Sobbe wildlife corridor.

4.1 Our case study: Sobbe wildlife corridor and the Sobbe conservancy

After its independence, Namibia started a more inclusive conservation approach based on principles of community-based natural resource management (CBNRM). This allowed communities to form a conservancy and to participate in and benefit from the management of wildlife and other natural resources. This conservation model is based on the assumption that acceptance towards wildlife will increase if people directly derive benefits from it (Mosimane and Silva 2015). Additionally, the legislation for forest resources was renewed in 2001, which enabled people to create community forests on communal land and to sustainably use and manage forest resources (Lavelle 2019).

Sobbe Conservancy is one of 15 registered conservancies in the Zambezi Region. It is part of the Mudumu landscape and bends around the northern and eastern sides of Mudumu National Park. The conservancy was founded in October 2006, covering an area of 404 km^2, with six main villages and a population of around 2000 people (NACSO 2008). The predominant language is Sifwe, and the majority of its residents

identify as Mafwe. Masida is the main village and the place where the traditional court, the *khuta*, is located. The *Induna Silalo*[2] belongs to the Chinchimane traditional authority. Prior to the registration of the conservancy, the Masida community forest and the adjoining Lubuta community forest of the neighbouring community were gazetted in February 2006[3]. The boundary between the community forests was set jointly with representatives of both communities and the neighbouring Mashi conservancy. However, when the coordinates for Sobbe conservancy were set, their boundaries reached further into the west and overlapped with Lubuta community forest. The shared piece of land contains a wildlife corridor, which is recognised to be of international importance for transboundary wildlife movements, especially for elephants and therefore is of great value for conservationist projects facilitating the movement of elephants from Botswana to Zambia via Mudumu National Park and a number of conservancies (KAZA Elephant Sub Working Group 2023). The local community knew the corridor for generations, as illustrated by this quote from a community game guard:

> "When I grew up, I knew that there is a corridor. In our language, we were not calling that corridor. We were calling it *kahito ke zipau* [where the animals are passing] in our language. And that corridor, it was there before our fathers. So, we found it there. Even the old people, our grandmothers, they knew that there is a corridor. Where the animals always pass from Zambia to Botswana, or cross to go anywhere. And that place, they were called *lunxhove*. X*howe* means thick bush where you don't go alone. It was a very dangerous area." (Interview, community game guard, 03.04.2023)

People on both sides of the corridor knew that it was a passage for animals and had long avoided this stretch of land, to prevent dangerous encounters with wildlife.

Sobbe wildlife corridor is a narrow strip of 20 km in length and 4 to 6 km in width. It is crossed by two roads and connects Mudumu National Park with the Zambezi State Forest (Fig. 3). Elephants use the corridor as a passage and often carry on into Zambia or Angola in the north or Botswana in the south. However, the corridor is not only important for elephants but is also used by at least 21 different mammal species such as aardvark, bush pig, and roan antelope, including 10 carnivores for example leopard (*Panthera pardus*), brown hyena (*Parahyaena brunnea*) and wild dog (*Lycaon pictus*) (Hanssen et al. 2020). The area is mainly covered by mopane (*Colophospermum mopane*) and Zambezi teak trees (*Baikaiaea plurijuga*), which serve as forage in the wet season. Additionally, the corridor contains water-filled pans after rains, where animals can drink and bathe. Elephants seek refuge in the forest cover during the day, and primarily move at night to avoid encounters with humans. The wooded strip is criss-crossed by three well-trodden paths that testify to their movements. In the wet season, the paths are marked with animal spoor and scattered elephant dung, some of it still gleamingly fresh and warm and some already

[2] A chief is the head of a local community, whereby areas of influence of different chiefs can overlap. A senior headman, or Induna Silalo, represents a number of villages, and each village has an Induna who represents a particular village.

[3] Government Gazette of the Republic of Namibia, No. 3590, Windhoek, 14. February, 2006.

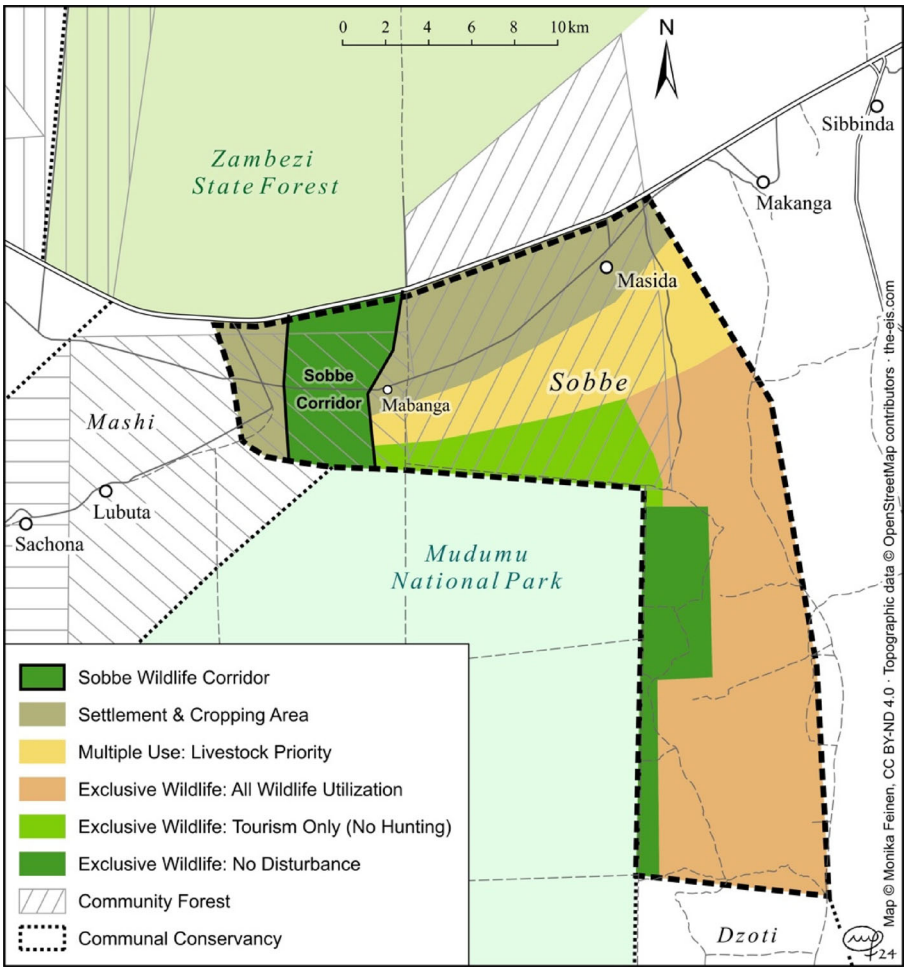

Fig. 3 Sobbe conservancy, Masida community forest and Lubuta community forest

stringy, corroded by dung beetles and other coprophages who feast on the leftovers. Inside the corridor, crooked trees with softened bark lean over the paths. Over the years, they were shaped by elephants who used the trees to scrub their backside. Despite their general avoidance of human settlements, some elephants break cover at night to devour the laboriously grown crop fields adjacent to the corridor, filled with maize, millet, sorghum or other delicacies such as watermelons and pumpkins. The wildlife corridor was a visible feature in the landscape that was shaped by elephants and other species, and was well known by the inhabitants of the area. However, the infrastructuring of the corridor further involved its official approval and inscription on maps as well as regular practices of patrolling and protection which followed its demarcation by the conservancy.

With the establishment of Sobbe conservancy, the "passage of the animals" was integrated in the zonation plan and renamed as "Sobbe wildlife corridor". The area

was zoned as an exclusive wildlife zone, which restricted human activities to the harvesting of forest products and controlled trophy hunting. The community game guards monitored the corridor through monthly patrols where they marched through the corridor looking for animal tracks and illegal activities. They noted their sightings in a so-called event book which is also used to create regional and national statistics of wildlife abundance and human-wildlife conflict. This led to a further standardisation of knowledge: wildlife using the corridor was recorded in a standardised manner and counted as a potential resource that could benefit the community. This regular monitoring also demonstrated the corridor's effectiveness as an environmental infrastructure. The game guards made awareness trainings with residents, explaining the ecological function of the corridor and rules of conduct. In 2016, the rules were tightened, and any human activities except crossings on the roads and monitoring through the community game guards were prohibited.

The importance of the wildlife corridor was further emphasised through the establishment of the KAZA TFCA (an administrative shift) and data from GPS-collars (a technological effort), which evidenced that elephants do not only frequent the corridor but use it to move from Botswana through Namibia into Zambia and Angola. Compared to other wildlife corridors in the region, where wildlife movements were increasingly blocked through human settlements, Sobbe positively stood out. However, in Sobbe, too, the infrastructuring of the corridor was contested and people started to farm and live closer to the wildlife passage since the late 2010s.

In 2018, the World Wide Fund for Nature (WWF) introduced a pilot project called "Wildlife Credits" in Sobbe conservancy, an initiative which is implemented in some Namibian conservancies to reward local communities for verifiable and quantifiable conservation outcome performance. The main goal was to diversify income opportunities from conservation beyond tourism and hunting, but also to create a sense of "stewardship" for the land. A contract was set up with a private company and with the agreement, the corridor was reframed in a capitalist logic which recognised its "ecosystem service" and the "wildlife conservation performance" of the conservancy. The conservancy received an annual payment of 40,000 Namibia Dollar[4] for the successful protection of the corridor which was split up between traditional authorities, the game guards, the conservancy and farmers who live close to the corridor[5]. In order to measure their efforts, another layer was added to the infrastructuring of the corridor and new technologies were integrated to create an "infrastructure of evidence" (Calkins and Rottenburg 2017). Satellite images were taken annually by the WWF to proof that the corridor was still kept free and that no new settlements or agricultural fields were encroaching on the area. A smart phone with a SMART app was introduced for the monthly game patrols. The app can be used to take pictures of live sightings and tracks such as spoors or fresh dung, but they also track the route and number of steps that was taken by the game guards. Additionally,

[4] Around 2000 Euros, or 2250 USD in April 2023.

[5] For the first three years the payments were made by Amarula/Distell Namibia. Afterwards they were financed through the National Wildlife Credits Fund Namibia. Another condition for the payments is compliance which includes the legally correct management and administration of the conservancy, for example the submission of required reports and good financial management.

32 camera traps were installed to evidence the presence and diversity of species in the corridor. Ideally, the data would be integrated into a platform and analysed via blockchain technology, which triggers the payments (Oberhauser 2019). Closely related to what Bowker et al. define as thinking infrastructures, the monitoring of the corridor made new quantifications and comparisons possible, and consequently, established new "valuation regimes that constitute orders of worth" (Bowker et al. 2019, p. 4). Different kinds of individual and collective human behaviour, like patrolling or encroachment could be evaluated through the technologies. However, the data also proved their good management and the "worth of the corridor" in the form of wildlife movements and species diversity. In the following section we present and discuss the intended, tolerated and unintended consequences of the infrastructuring of Sobbe wildlife corridor.

4.2 Intended, tolerated and unintended consequences

Infrastructuring extends beyond the construction of material elements, leading to significant changes in societies, work, values, life, and language. The implementation process involves heterogeneous elements and social practices, requiring a degree of flexibility to ensure that infrastructures function effectively (Niewöhner 2015). Nevertheless, infrastructure projects often fail, are repurposed, resisted, or have other unintended consequences (Knox and Gambino 2023). In this section, we will explore the intended, tolerated, and unintended consequences that accompanied the infrastructuring of the Sobbe wildlife corridor.

4.3 Intended consequences

The wildlife corridor strategy of Namibia's Zambezi Region (2021) formulates three main reasons for the maintenance of wildlife corridors: reducing human-wildlife conflict, protecting and enhancing the wildlife economy and preserving habitat connectivity and wildlife diversity, which contributes to local livelihoods.

The Zambezi Region is an important passage for elephants that migrate from Botswana through Namibia into Zambia and Angola. These routes were severely interrupted by the Angolan civil war and the Namibian war of liberation. Poaching was rampant in the region. The Angolan civil war (1975–2002) displaced more than four million people and had devastating consequences for the country, its people, but also for wildlife. In south-eastern Angola, elephants were decimated in large numbers. Estimates of pre-war elephant populations vary widely, therefore there are no reliable numbers about the losses. However, some estimated that up to 100,000 elephants were killed. This slaughter was facilitated by the introduction of firearms and driven by the ivory trade, which helped finance the war (Braga-Pereira et al. 2020; Chase and Curtice 2011). Due to its proximity to what is today called Luengue-Luiana National Park in Angola, which served as a military base in the civil war, wildlife in the Zambian Sioma Ngwezi National Park was equally targeted by poachers (Chase and Griffin 2008). Besides the illegal killing of wildlife, it is assumed that elephants sought refuge in Botswana, where elephant numbers have been constantly growing (Lindsay et al. 2017). Through aerial surveys and GPS-collar

data a recolonisation of both parks in Zambia and Angola could be observed and the Zambezi region and its wildlife corridors is seen as the critical link to facilitate this repopulation.

Maintaining these corridors in Namibia is crucial for KAZA's goal of redistributing elephants into less populated areas in Angola and Zambia. The latest elephant count in Angola's KAZA region estimated a population of 5983, up from 3395 in 2016. In Zambia's KAZA region, however, the population dropped from 6736 in 2016 to 3840 in 2022 (Bussière and Potgieter 2023). These figures should be interpreted with caution, as they are estimates, and the survey design changed between counts (Schlossberg and Chase 2024). For example, a single herd of over 500 elephants was observed in 2022, which could explain some of the drastic changes in population estimates. Despite the fluctuations in Zambia, there is hope that national parks in Zambia and Angola will become a refuge for elephant populations and a necessary precondition seems to be the Sobbe wildlife corridor. Currently, the Zambian and Angolan part of KAZA hold only 4% of KAZA's elephant population, so if corridors remain open, repopulation is a real possibility.

Given that many corridors in the Zambezi Region are increasingly obstructed by human activity, particular emphasis is placed on the Sobbe corridor. As noted in the KAZA Elephant Policy Brief: "In particular, the Sobbe corridor in the Zambezi region of Namibia is an important transfrontier corridor" (KAZA Elephant Sub Working Group 2023, p. 13). However, besides the "ecological function" of a corridor, the communities living with wildlife are key for their survival. During an interview with the WWF Namibia, a person who implements the Wildlife Credits scheme in Sobbe conservancy highlighted the exceptional commitment of the community:

> "Sobbe conservancy became a very big priority not only because of the corridor itself but because these community members have actually kept that corridor open and have given up that land for conservation, because that's how important it is. That's how much value they put to that. Of course, now there are more issues economic wise, more pressure, more people and so the question is: How can we help Sobbe maintain that corridor with growing [elephant] numbers in Botswana?" (Interview, WWF Namibia, 22.08.2023).

In order to maintain wildlife corridors successfully, minimising human encroachment is essential, but it is seen as equally important to foster community tolerance for wildlife and positive attitudes towards conservation. In Sobbe Conservancy, the Wildlife Credits Model has created not only a financial incentive system but also a framework of moral values that rewards community members for their conservation efforts. The incentive scheme is directly connected to the infrastructure of the corridor and by commodifying it entrenches its value. Although not all inhabitants living in the conservancy had positive attitudes towards the corridor, the performance payment scheme had a significant impact on attitudes, as this quote from a community game guard illustrates:

> "I think we are benefitting a lot from the corridor. Yes, let me say, we even managed to get a registration [for the conservancy] of the Ministry of Environment

because of the corridor. If the corridor could not be there, we could not have enough species. And the ministry could not give us a quota. Without a corridor we could not have a quota. I think that is the first importance or the first benefit from the corridor. We get trophies because of the corridor. People are employed in Sobbe conservancy because of the corridor. We are called game guards because of the corridor. Currently now, we received or we always get a 40,000 [Namibia-Dollar] from the wildlife credits. We always get 40,000 every year. So all these are benefits of Sobbe conservancy or Masida communities from the corridor. So the corridor is very much important. It's not only for Sobbe. Let me say for these people who are living in Zambia or Botswana or this side of Dzoti, Bamunu, Balayerwa, Mashi, Kwandu and Mayuni they are benefitting, they get species or wild animal from the corridor." (Interview, Community game guard, 03.04.2023)

By integrating the corridor into the social, political, financial and spatial network of the community, elephant mobilities were infrastructured and new identities, practices and values were established. The corridor changed human-wildlife relations as it enabled the community to receive hunting quotas from the ministry. Additionally new identities and professions such as community game guards were created, skills were trained or refined, and new practices like monitoring and patrolling were exercised. The Wildlife Credits Model, further connected them with a network of international conservationists and payers, strengthening pride and ownership towards the wildlife corridor. As a result of the positive attention, the Namibian Nature Foundation started a cluster fencing project to protect agricultural fields near Sobbe corridor, and the conservancy received a national award for their conservation efforts in 2023 (Jacobsohn 2023).

4.4 Tolerated consequences

There is a set of consequences which is certainly not welcomed but is tolerated. Human-elephant conflict in the region is frequent and it is a matter of concern for the local community. Quantitative data supplied by NACSO, however, shows that human-elephant conflict is not all concentrated along or within the corridor. Human-elephant conflict prevails in areas where human settlement is dense. Figure 4 shows that human-elephant conflict is most intense along the roads where fields are clustered. Human-elephant conflict is frequent when maize ripens on the fields, i.e. between February and April (see Fig. 5). Over the remainder of the year there is much less human-elephant interaction. In order to minimise conflicts along and within corridor terrain, conservancies strongly discourage any settlement in corridors. People who have fields inside the corridor are not entitled to any compensation if their crops are damaged.

Figure 4 shows that human-elephant conflict is prevalent along the zones of dense settlement which run along the major roads. Such conflicts are much less frequent along most parts of the corridors.

Human-elephant conflict is an expected consequence connected to wildlife corridors and facilitating NGOs in conjunction with the respective ministry have tried

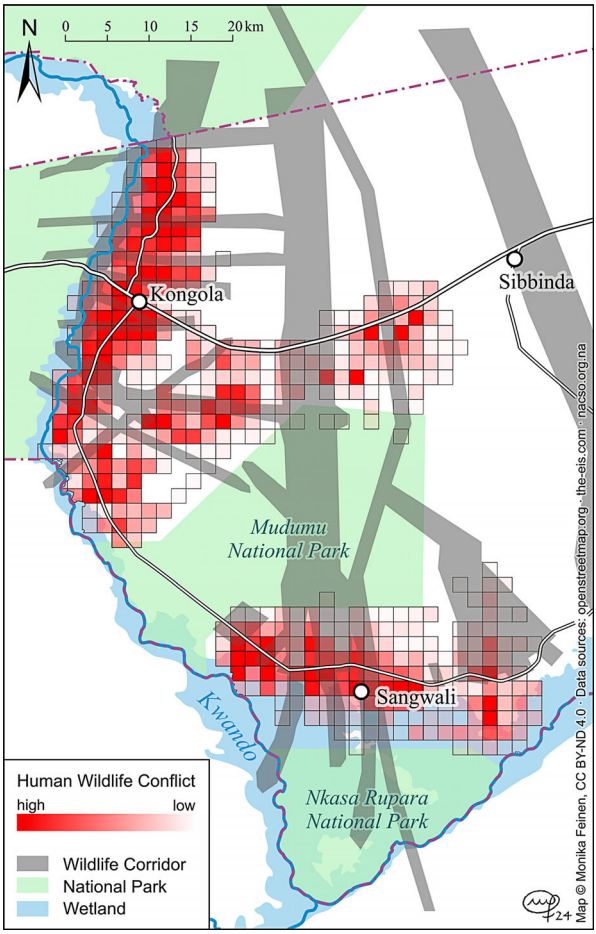

Fig. 4 Distribution of human-elephant conflict in the Mudumu landscape

hard to find adequate compensation procedures. These consequences are much discussed locally, and claims that contemporary compensation for wildlife damage is insufficient are frequent (Bollig 2024).

4.5 Unintended consequences

The formal establishment of the Sobbe corridor also led to political strife: a consequence of this conservationist move that had not been anticipated. Sobbe's neighbouring community, Lubuta, has a registered community forest that includes the same piece of land as Sobbe's wildlife corridor. However, the people there did not benefit from the Wildlife Credits Model, but were rather excluded from the land through the infrastructuring of the corridor. Lubuta formally falls under Mashi Conservancy, which was founded in 2003. Yet, Lavelle (2019) describes that the community of Lubuta wished to further secure the forest resources and to diversify possibilities for income by registering a community forest. Despite their efforts, the

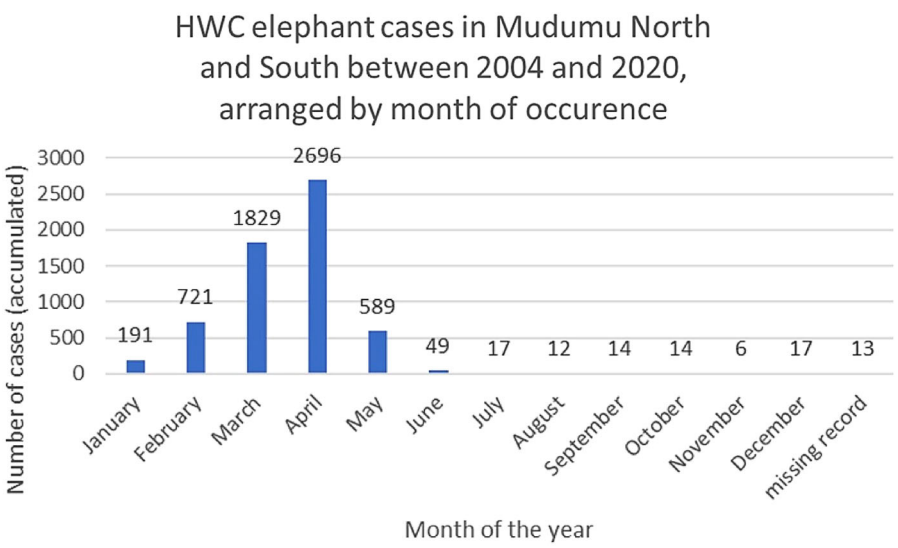

Fig. 5 Peeks of elephant damage in the Mudumu landscape

community received only little support from the government or NGOs and couldn't increase their benefits from the forest. Lavelle further stresses that different NGOs in Namibia support conservancies, but none specifically targeted community forests (ibid.). The overlap with Sobbe conservancy and Sobbe's regular income through the Wildlife Credits payments led to further frustration in Lubuta.

Between December 2023 and January 2024, local NGOs and the MEFT set up road signs to mark 60 corridors in the whole Zambezi Region. At the Sobbe wildlife corridor, four signs were erected along the tarred road B8 and the gravel road to mark its beginning and ending. The rectangular, brown panels bore the inscription "Caution. Sobbe Wildlife Corridor. Drive with care" in English and Silozi. A few days after the signposting, a field was cleared and fenced within the corridor (Fig. 6). The owner of the field came from Lubuta and received the land from their Induna.

During a focus group discussion with traditional authorities and members from Lubuta a few weeks later, one of the Indunas explained their motives: "This portion of land does not belong to Sobbe. Our ancestral land is where the corridor is. Masida is benefitting while Lubuta gets nothing. Masida can get an income from the corridor, they are not sharing that money. The wildlife is passing and damaging our crops. We are farming close to the corridor. No one pays for our damage." Another senior Induna further added: "If with that corridor, there will be no agreements to share benefits, then it will not be there. Even the sign board, they just put them without knowing, they just put them like someone who wants to fight. From my experience animals cannot read this, the only ones who can read it are people. It's an insult on our land". He concluded laconically: "Before the conservancy came, people did not know that this land is useful, it had no importance, now there is money and a conflict" (Focus group discussion Lubuta, 10.02.2023).

Fig. 6 Newly constructed fence inside Sobbe corridor, photo taken by Emilie Köhler

The longstanding success of the corridor was partly based on its avoidance by humans, but since it was recognised as a key corridor for elephant movements that was in need of protection, new dilemmas emerged, which the initiator of the Wildlife Credits project summarised it as follows: "We always knew that this area was very valuable to the elephants, because of the collars. So, we knew that was a key area, but putting more focus on it, it worries me. It worries me that researchers are going there, it worries me that people like us are going there. Because that has been there for hundreds of years and communities have accepted it. Now we are putting so much attention to it, I hope we are not going to disrupt it and politicise it (Interview 02.05.2023)."

This case illustrates the unintended consequences that can arise when the environment is infrastructured and new environmental and social orders are created. Even though the community forest of Lubuta still existed, the prioritisation of elephant mobilities and the infrastructuring of the corridor became more and more dominant. Most of the practices and materialities like the monitoring through satellites, camera traps, and foot patrols remained largely invisible to the neighbouring Lubuta community. However, the demarcation through road signs by the government was experienced as an affront to their land rights and led to an escalation of the conflict. Besides the land dispute, the prioritisation of elephant mobilities privileged only one aspect of the environment and excluded the neighbouring Lubuta community and their relations with the forest. Additionally, they didn't experience the elephant movements as linear flows as portrayed on the map, whose negative effects can be credited to only one community. Rather, elephant movements are more dispersed and uncertain which meant that—from the local perspective—the inhabitants of Lubuta suffered equally from crop-raiding elephants, but were excluded from economic benefits. The infrastructuring of the corridor changed the local value extraction of natural products and transformed a dangerous and largely avoided area into a monitored and protected space of global value. Although the NGO aimed to provide Sobbe conservancy with an income to maintain the corridor and to foster a sense

of stewardship, the project inadvertently resulted in less acceptance and increased social conflict within the neighbouring Lubuta community.

5 Conclusion

This study has highlighted the growing importance of wildlife corridors as integral components of conservation landscapes. We have demonstrated that these corridors arise from the collaborative actions of both humans and wildlife. The development of these corridors begins with more-than-human practices, such as the repeated use of pathways by elephants and the transgenerational transfer of this knowledge. Yet, elephant mobilities are deeply intertwined with local knowledge, administrative processes, and monitoring technologies. Anthropogenic representations of elephants and other wildlife permeate policy documents, international forums, data-sharing agreements, and digital platforms. Through the establishment of international information infrastructures capturing elephant mobilities, conservation landscapes like the KAZA TFCA are reimagined on a grand scale.

These efforts have profound impacts in communities. Places on the fringes of tourism and conservation, such as Sobbe Conservancy, are transformed into core centers for transnational conservation efforts. As these wildlife corridors are further developed with the involvement of local communities, new rules, practices, languages, and values emerge. This can yield positive outcomes, such as increased recognition of the daily challenges and conservation efforts experienced by local communities. However, the infrastructuring of elephant mobility in Sobbe eventually faced resistance from the neighbouring Lubuta community, which became increasingly marginalised as their community forests—less appealing to donors and the wildlife economy—left them alienated from the land.

Environmental infrastructures are inherently complex, involving processes at various scales and comprising diverse elements. The "ontological multiplicity of their constituent components" (Jensen 2015) poses challenges, since people may protect the same space for different reasons. Therefore, human behavior should not only be considered in connectivity plans (Ghoddousi et al. 2021); but it is equally crucial to explore what humans value in the landscapes they protect, as seen in the case of the Lubuta community forest.

Despite the inherent dangers and conflicts in shared human-elephant spaces, many scholars emphasise the deep, shared history between the two species and reject the notion of spatial separation (Evans and Njeri Nduguta 2023; Jadhav and Barua 2012; Lorimer 2010; Thekaekara 2018). Building on this perspective, we argue that wildlife corridor planning and maintenance must incorporate an environmental justice approach. This approach should include distributional justice, ensuring fair access to land and resources, participatory engagement of local communities, and the recognition that both wildlife and humans have legitimate entitlements to these shared landscapes.

Acknowledgements We express our gratitude to the government of Namibia for granting permission to conduct fieldwork. We thank the traditional authorities and communities for their time, knowledge and permission to conduct research. Thanks to the conservancy management, the community game guards and

the inhabitants of Sobbe and Kwandu conservancy, the Ministry of Environment, Forestry and Tourism in Namibia, the WWF Namibia, Kwando Carnivore Project, the Namibia Nature Foundation and the Integrated Rural Development and Nature Conservation for allowing us to interview and accompany you.

Funding This paper was written as part of a research project that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 101020976).

Funding Open Access funding enabled and organized by Projekt DEAL.

Conflict of interest E. Köhler and M. Bollig declare that they have no competing interests.

References

van Aarde RJ, Jackson TP (2007) Megaparks for metapopulations: addressing the causes of locally high elephant numbers in southern Africa. Biol Conserv 134(3):289–297. https://doi.org/10.1016/j.biocon.2006.08.027

Adams TSF, Leggett KEA, Chase MJ, Tucker MA (2022) Who is adjusting to whom?: differences in Elephant Diel activity in wildlife corridors across different human-modified landscapes. Front Conserv Sci. https://doi.org/10.3389/fcosc.2022.872472

Barua M (2021) Infrastructure and non-human life: a wider ontology. Prog Hum Geogr 45(6):1467–1489. https://doi.org/10.1177/0309132521991220

Bates L (2018) Elephants: studying cognition in the African Savannah. In: Bueno-Guerra N, Amici F (eds) Field and laboratory methods in animal cognition. Cambridge University Press, Cambridge, pp 177–198. https://doi.org/10.1017/9781108333191.010

Bates L, Sayialel KN, Njiraini NW, Poole JH, Moss CJ, Byrne RW (2008) African elephants have expectations about the locations of out-of-sight family members. Biol Lett 4(1):34–36. https://doi.org/10.1098/rsbl.2007.0529

Blok A, Nakazora M, Winthereik BR (2016) Infrastructuring environments. Sci Cult 25(1):1–22. https://doi.org/10.1080/09505431.2015.1081500

Bollig M (2024) Wildlife corridors in a southern African conservation landscape: the political ecology of multispecies mobilities along the arteries of Anthropogenic conservation. Anthropol South Africa 47(2):216–235. https://doi.org/10.1080/23323256.2024.2327467

Bollig M, Krause F (2023) Environmental anthropology: current issues and fields of engagement. UTB

Bowker GC, Star SL (1999) Sorting things out: classification and its consequences. MIT Press https://doi.org/10.7551/mitpress/6352.001.0001

Bowker GC, Elyachar J, Kornberger M, Mennicken A, Miller P, Nucho JR, Pollock N (2019) Introduction to thinking infrastructures. In: Kornberger M, Bowker GC, Elyachar J, Mennicken A, Miller P, Nucho JR, Pollock N (eds) Thinking infrastructures. Research in the sociology of organizations. Emerald Publishing Limited, Leeds, pp 1–13 https://doi.org/10.1108/S0733-558X20190000062001

Braga-Pereira F, Bogoni JA, Nóbrega Alves RR (2020) From spears to automatic rifles: the shift in hunting techniques as a mammal depletion driver during the Angolan civil war. Biol Conserv 249:108744. https://doi.org/10.1016/j.biocon.2020.108744

Brennan A, Beytell P, Aschenborn O, Du Preez P, Funston PJ, Hanssen L, Kilian JW, Stuart-Hill G, Taylor RD, Naidoo R (2020) Characterizing multispecies connectivity across a transfrontier conservation landscape. J Appl Ecology 57(9):1700–1710. https://doi.org/10.1111/1365-2664.13716

Buchholtz EK, Spragg S, Songhurst A, Stronza A, McCulloch G, Fitzgerald LA (2021) Anthropogenic impact on wildlife resource use: spatial and temporal shifts in elephants' access to water. Afr J Ecol 59(3):614–623. https://doi.org/10.1111/aje.12860

Buchholtz EK, McDaniels M, McCulloch G, Songhurst A, Stronza A (2023) A mixed-methods assessment of human-elephant conflict in the western Okavango Panhandle, Botswana. People Nat 5(2):557–571. https://doi.org/10.1002/pan3.10443

Bussière E, Potgieter D (2023) Results and technical report. KAZA Elephant Survey 2022, vol I. KAZA TFCA Secretariat, Kasane

Calkins S, Rottenburg R (2017) Evidence, infrastructure and worth. In: Harvey P, Jensen C, Morita A (eds) Infrastructures and social complexity. A companion. Routledge, New York, London (https://www.academia.edu/29783419/Evidence_Infrastructure_and_Worth_In_Infrastructures_and_Social_Complexity_eds_Harvey_Jensen_and_Morita_2016_Routledge_)

Chase M, Griffin C (2008) Seasonal abundance and distribution of elephants in Sioma Ngwezi national park, southwest Zambia. Pachyderm 45:

Chase MJ, Curtice RG (2011) Elephants of south-east Angola in war and peace: their decline, re-colonization and recent status. Afr J Ecol 49(3):353–361. https://doi.org/10.1111/j.1365-2028.2011.01272.x

Dittmann J (2024) Paper Park? Politik grenzübergreifenden Naturschutzes in Nordost-Namibia. LIT, Münster. ISBN 978-3-643-15581-8.

Evans LA, Njeri Nduguta R (2023) The implications of being a "problem" elephant. In: Lainé Keil NPG, Rahmat K (eds) Composing worlds with elephants : interdisciplinary dialogues. IRD Éditions, Mondes Vivants, pp 83–100 https://doi.org/10.4000/books.irdeditions.47275

Garstang M (2015) Elephant sense and sensibility: behavior and cognition, pp 1–133

Gaynor KM (2019) 'Spatial and temporal responses of animals to landscape heterogeneity, predation risk, and human activity'. PhD, UC Berkeley. https://escholarship.org/uc/item/2w48t95n

Gaynor KM, Paola SB, Long RA, Gonçalves DD, Granli PK, Poole JH (2018) Effects of human settlement and roads on Diel activity patterns of elephants (Loxodonta Africana). Afr J Ecol 56(4):872–881. https://doi.org/10.1111/aje.12552

Ghoddousi A, Buchholtz EK, Dietsch AM, Williamson MA, Sharma S, Balkenhol N, Kuemmerle T, Dutta T (2021) Anthropogenic resistance: accounting for human behavior in wildlife connectivity planning. One Earth 4(1):39–48. https://doi.org/10.1016/j.oneear.2020.12.003

Goldenberg SZ, Wittemyer G (2020) Elephant behavior toward the dead: a review and insights from field observations. Primates 61(1):119–128. https://doi.org/10.1007/s10329-019-00766-5

Green A, Sandbrook C (2021) Beyond connectivity: an exploration of expert perspectives on conservation corridors. Geoforum 127:257–268. https://doi.org/10.1016/j.geoforum.2021.11.002

Hanks J (2003) Transfrontier Conservation Areas (TFCAs) in Southern Africa. J Sustain For 17(1–2):127–148. https://doi.org/10.1300/J091v17n01_08

Hanssen L, Mutendelwa Kufwa B, Ngoshi LS, Mushohaule Mbozi M, Litabani Muyumbano F, Babane Nayowa R (2020) Progress Report to WWF in Namibia. (Grant FE 41) Monitoring the Sobbe Corridor: Identifying Biodiversity Hotspots, Species Diversity and Monitoring Population Trends in Important Wildlife Connectivity Areas in the State Forest. Kwando Carnivore Project

Harris C (2018) The linguistic dilemma in Namibia's zambezi region: is the dominance of the Silozi language a curse or a blessing

Hilty J, Lidicker W, Merenlender A (2006) Corridor ecology: the science and practice of linking landscapes for biodiversity conservation. Island Press, Washington DC

Hodgetts T, Lorimer J (2020) Animals' mobilities. Prog Hum Geogr 44(1):4–26. https://doi.org/10.1177/0309132518817829

Huang RM, van Aarde RJ, Pimm SL, Chase MJ, Leggett K (2022) Mapping Potential Connections between Southern Africa's Elephant Populations'. Edited by Bi-Song Yue. PLoS ONE 17(10):e275791. https://doi.org/10.1371/journal.pone.0275791

Jacobsohn M (2023) Investing in conservation. Sobbe conservancy, Namibia. African Wildl Environ 84:34–39

Jadhav S, Barua M (2012) The elephant vanishes: impact of human-elephant conflict on people's wellbeing. Health Place 18(6):1356–1365. https://doi.org/10.1016/j.healthplace.2012.06.019

Jensen C (2015) Experimenting with political materials: environmental infrastructures and ontological transformations. Distinktion J Soc Theory 16(1):17–30. https://doi.org/10.1080/1600910X.2015.1019533

Kalvelage L, Revilla Diez J, Bollig M (2020) How much remains? Local value capture from tourism in Zambezi, Namibia. Tour Geogr. https://doi.org/10.1080/14616688.2020.1786154

Kalvelage L, Revilla Diez J, Bollig M (2021) Do tar roads bring tourism? Growth corridor policy and tourism development in the Zambezi region, Namibia. Eur J Dev Res 33(4):1000–1021. https://doi.org/10.1057/s41287-021-00402-3

KAZA Elephant Sub Working Group (2023) KAZA policy brief: elephant movements and connectivity in the Kavango Zambezi transfrontier area

KAZA TFCA Secretariat (2019) Strategic planning framework for the conservation and management of elephants in KAZA TFCA. KAZA TFCA Secretariat, Kasane

Knox H, Gambino E (2023) 'Infrastructure'. Cambridge encyclopedia of anthropology. https://www.anthroencyclopedia.com/entry/infrastructure

Kreike E (2013) Environmental infrastructure in African history: examining the myth of natural resource management in Namibia. Studies in environment and history. Cambridge University Press, Cambridge https://doi.org/10.1017/CBO9781139026123

Krieg L, Barua M, Fisher M (2020) Ecologizing infrastructure: infrastructural ecologies. Introduction to the forum in society & space. https://www.societyandspace.org/forums/ecologizing-infrastructure-infrastructural-ecologies.

Lavelle J-J (2019) Digging deeper for benefits: rural local governance and the livelihood and sustainability outcomes of devil's claw (Harpagophytum Spp.) harvesting in the zambezi region, Namibia

Lindsay K, Chase M, Landen K, Nowak K (2017) The shared nature of Africa's elephants. Biol Conserv 215:260–267. https://doi.org/10.1016/j.biocon.2017.08.021

Loarie SR, van Aarde RJ, Pimm SL (2009) Elephant seasonal vegetation preferences across dry and wet savannas. Biol Conserv 142(12):3099–3107. https://doi.org/10.1016/j.biocon.2009.08.021

Lorimer J (2010) Elephants as companion species: the lively biogeographies of Asian elephant conservation in Sri Lanka: elephants as companion species. Trans Inst British Geog 35(4):491–506. https://doi.org/10.1111/j.1475-5661.2010.00395.x

MEFT (2021a) An overview of elephant conservation and management in Namibia'. Windhoek: Republic of Namibia. http://the-eis.com/elibrary/sites/default/files/downloads/literature/An%20overview%20of%20elephant%20conservation%20and%20management%20in%20Namibia.pdf

MEFT (2021b) Wildlife corridors of the Zambezi region—"A strategy for their maintenance, conservation, socio-economic development and human wildlife conflict management. Republic of Namibia, Windhoek

MEFT, NACSO (2022) The state of community conservation in Namibia (annual report 2021). MEFT/NACSO, Windhoek

MEFT, NACSO (2023) The state of community conservation in Namibia (annual report 2022). MEFT NACSO, Windhoek

Ministry of Environment, Forestry and Tourism (2020) National elephant conservation and management plan 2021/2022-2030/2031

Mlilo M, Bollig M, Revilla Diez J (2024) Nation-state influence on tourism path creation in Southern Africa. Reg Stud. https://doi.org/10.1080/00343404.2024.2393685

MLR, Ministry of Lands and Resettlement (2015a) Baseline Report for the Zambezi Integrated Regional Land-Use Plan, (Vol. 1)'. Windhoek: Republic of Namibia. https://library.wur.nl/ojs/index.php/Botswana_documents/article/view/16085

MLR, Ministry of Lands and Resettlement (2015b) Integrated regional land use plan for the Zambezi region vol 2. Republic of Namibia, Windhoek

Mosimane A, Silva J (2015) Local governance institutions, CBNRM, and benefit-sharing systems in Namibian conservancies. J Sustain Dev. https://doi.org/10.5539/jsd.v8n2p99

Mosimane A, Matengu K, Bollig M (2023) Conservation, traditional authorities, and the commodification of the 'Wild': A Namibian perspective, in: Conservation, markets and the environment in Southern and Eastern Africa, edited by Bollig M, Mosimane A, Nghitevelekwa R, Lendelvo S, 376–402. Boydell and Brewer. https://doi.org/10.1515/9781800106642-019.

NACSO (2008) Namibia's communal conservancies: a review of progress and challenges in 2007. NACSO, Windhoek

NACSO (2022) Sobbe natural resource report. NACSO, Windhoek

Naidoo R, Beytell P, Brennan A, Kilian W, McCulloch G, Stronza A, Taylor R, Tsholofelo C, Songhurst A (2022) Challenges to elephant connectivity from border fences in the world's largest transfrontier conservation area. Front Conserv Sci. https://doi.org/10.3389/fcosc.2022.788133

Nevo O, Schmitt MH, Ayasse M, Valenta K (2020) Sweet tooth: elephants detect fruit sugar levels based on scent alone. Ecol Evol 10(20):11399–11407. https://doi.org/10.1002/ece3.6777

Niewöhner J (2015) Infrastructures of society, anthropology of. In: International encyclopedia of the social & behavioral sciences. Elsevier, pp 119–125 https://doi.org/10.1016/B978-0-08-097086-8.12201-9

Oberhauser D (2019) Blockchain for environmental governance: can smart contracts reinforce payments for ecosystem services in Namibia? Front Blockchain. https://doi.org/10.3389/fbloc.2019.00021
O'Connell-Rodwell CE (2007) Keeping an "ear" to the ground: seismic communication in elephants. Comp Biochem Physiol A Physiol 22(4):287–294. https://doi.org/10.1152/physiol.00008.2007
Plotnik J, Brubaker D, Dale R, Tiller L, Mumby H, Clayton N (2019) Elephants have a nose for quantity. Proc Natl Acad Sci USA 116:201818284. https://doi.org/10.1073/pnas.1818284116
Polansky L, Kilian J, Wittemyer G (2015) Elucidating the significance of spatial memory on movement decisions by African Savannah elephants using state-space models. Proceedings Biol Sci Royal Soc. https://doi.org/10.1098/rspb.2014.3042
Purdon A, Mole MA, Chase MJ, van Aarde RJ (2018) Partial migration in Savanna elephant populations distributed across Southern Africa. Sci Rep 8(1):11331. https://doi.org/10.1038/s41598-018-29724-9
Revilla Diez J, Hulke C, Kalvelage L (2023) Value chains and global production networks: conceptual considerations and economic development in the "wild". In: Bollig M, Lendelvo S, Mosimane A, Nghitevelekwa R (eds) Conservation, markets & the environment in southern and Western Africa. Future Rural Africa. James Currey, Melton, pp 56–78 https://doi.org/10.1515/9781800106642-007
Rodwell T (1995) Caprivi elephant monitoring project. Ministry of Environment and Tourism, Windhoek
Scheffler U (2016) Ecosystem services assessment and valuation in regional spatial planning in Namibia-the case of the Zambezi integrated regional land-use plan. In: IAIA16 conference proceedings, resilience and sustainability Aichi-Nagoya
Schlossberg S, Chase M (2024) Population trends and conservation status of elephants in Botswana and the Kavango Zambezi transfrontier conservation area. Elephants Without Borders, Kasane (https://elephantswithoutborders.org/site/wp-content/uploads/Final-EWB-Ele-Pop-Trends-KAZA-report-Mar24.pdf)
Schmitt MH, Shuttleworth A, Ward D, Shrader AM (2018) African elephants use plant odours to make foraging decisions across multiple spatial scales. Anim Behav 141:17–27. https://doi.org/10.1016/j.anbehav.2018.04.016
Shortridge GC (1934) The mammals of south West Africa: a biological account of the forms occurring in that region vol 1. William Heinemann, London
Skinner N (2014) African elephant numbers collapsing. Nature. https://doi.org/10.1038/nature.2014.15732
Spradley JP (2016) The ethnographic interview, 2nd edn. Waveland Press, Long Grove
Star SL, Bowker GC, Neumann LJ (2003) Transparency beyond the individual level of scale: convergence between information artifacts and communities of practice. In: Peterson-Kemp A, Van House N, Buttenfield B (eds) Digital library use: social practice in design and evaluation. MIT Press, Cambridge (https://direct.mit.edu/books/edited-volume/3828/chapter/125553/Transparency-beyond-the-Individual-Level-of-Scale)
Thekaekara T (2018) Thinking like an elephant, looking beyond protected areas. In: Shonil Bhagwat (ed) Conservation and development in India. Routledge, London, pp 83–108
Tickle L, Tavaziva V, Thulin C-G (2024) Stakeholder perceptions of solutions for sustainable management of the African elephant, Loxodonta Africana. Wildlife Biol. https://doi.org/10.1002/wlb3.01150
Tiller L, Humle T, Amin R, Humphries A, Seaman D, Sitati N, Smith R (2024) Elephant pathway use in a human-dominated landscape. Wildlife Biol. https://doi.org/10.1002/wlb3.01204
Wood M, Chamaillé-Jammes S, Hammerbacher A, Shrader AM (2022) African elephants can detect water from natural and artificial sources via olfactory cues. Anim Cogn 25(1):53–61. https://doi.org/10.1007/s10071-021-01531-2