The forgotten link between northern and southern Tanzania

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SHORT COMMUNICATION

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The forgotten link between northern and southern Tanzania

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Abstract

We present a method to rapidly assess the current status and location of wildlife corridors using interviews, and provide an update on the corridors linking Wami-Mbiki Wildlife Management Area to surrounding protected areas in eastern Tanzania. Wami-Mbiki is often considered an important corridor hub linking four protected areas: Mikumi and Saadani National Parks, the Selous Game Reserve, and the Handeni Game Controlled Area, and is thus potentially the last link between the savannas of northern Tanzania with the miombo forests of southern Tanzania. Currently, none of its corridors are under protection. As Tanzania now has committed to maintain connectivity between protected areas and the regulatory means to do so, it is now more pressing than ever for researchers to delineate the exact locations of wildlife corridors.

KEYWORDS
Tanzania, Wami-Mbiki wildlife management area, wildlife corridor

1 | INTRODUCTION

Wildlife corridors provide vital linkages between protected areas but across Africa but are deteriorating rapidly (Epps, Wasser, Keim, Mutayoba, & Brashares, 2013; Newmark, 2008; Riggio & Caro, 2017). Therefore, there is an urgent need to identify the location of wildlife corridors and stepping stones of habitat that still persist between reserves in order to maintain wildlife movements (Tucker et al., 2018).

Wami-Mbiki Wildlife Management Area (WMA) in eastern Tanzania is often considered an important corridor hub linking four protected areas: Mikumi and Saadani National Parks (NPs), the Selous Game Reserve (GR) and the Handeni Game Controlled Area (GCA) (Jones, Caro, & Davenport, 2009; Riggio & Caro, 2017). Currently, none of its wildlife corridors are under protection. In 2009, the Tanzania Wildlife Research Institute (TAWIRI) compiled a summary of the wildlife corridors remaining in the country (Jones et al., 2009). All four of these corridors were categorized as "Unconfirmed" (having only anecdotal information on wildlife movements [Caro, Jones, & Davenport, 2009;]) and were classified as being in "Critical" or "Extreme" condition—estimated to have <5 years remaining (Debonnet & Nindi, 2017). This is of concern because Wami-Mbiki WMA potentially constitutes the last link between protected areas and biomes in northern and southern Tanzania (Debonnet & Nindi, 2017; Riggio & Caro, 2017).

Tanzania is committed to maintain connectivity between protected areas (Kikoti, Griffin, & Pamphil, 2010) and has the regulatory means to do so (United Republic of Tanzania 2009), so it is now vital to delineate exact locations of wildlife corridors. Here, we present a method to rapidly assess the current status and location of wildlife corridors using interviews and provide an update on the Wami-Mbiki corridor hub.

2 | METHODS

2.1 | Study area

Our study took place around Wami-Mbiki WMA in Morogoro, Pwani and Tanga Regions, eastern Tanzania. Wami-Mbiki is an approximately 2,500 km^2 conservation area managed by the Wami-Mbiki Society surrounded by 24 member villages and farmland (TAWIRI 2009) (Figure 1).

2.2 | Interviews

In January and November 2014, we conducted semi-structured interviews in Swahili concerning large mammal movements around 65 villages surrounding Wami-Mbiki (Figure 1). For each survey, we first gained the permission of the Village Executive Officer and/or Village Chairperson to conduct interviews with members of the

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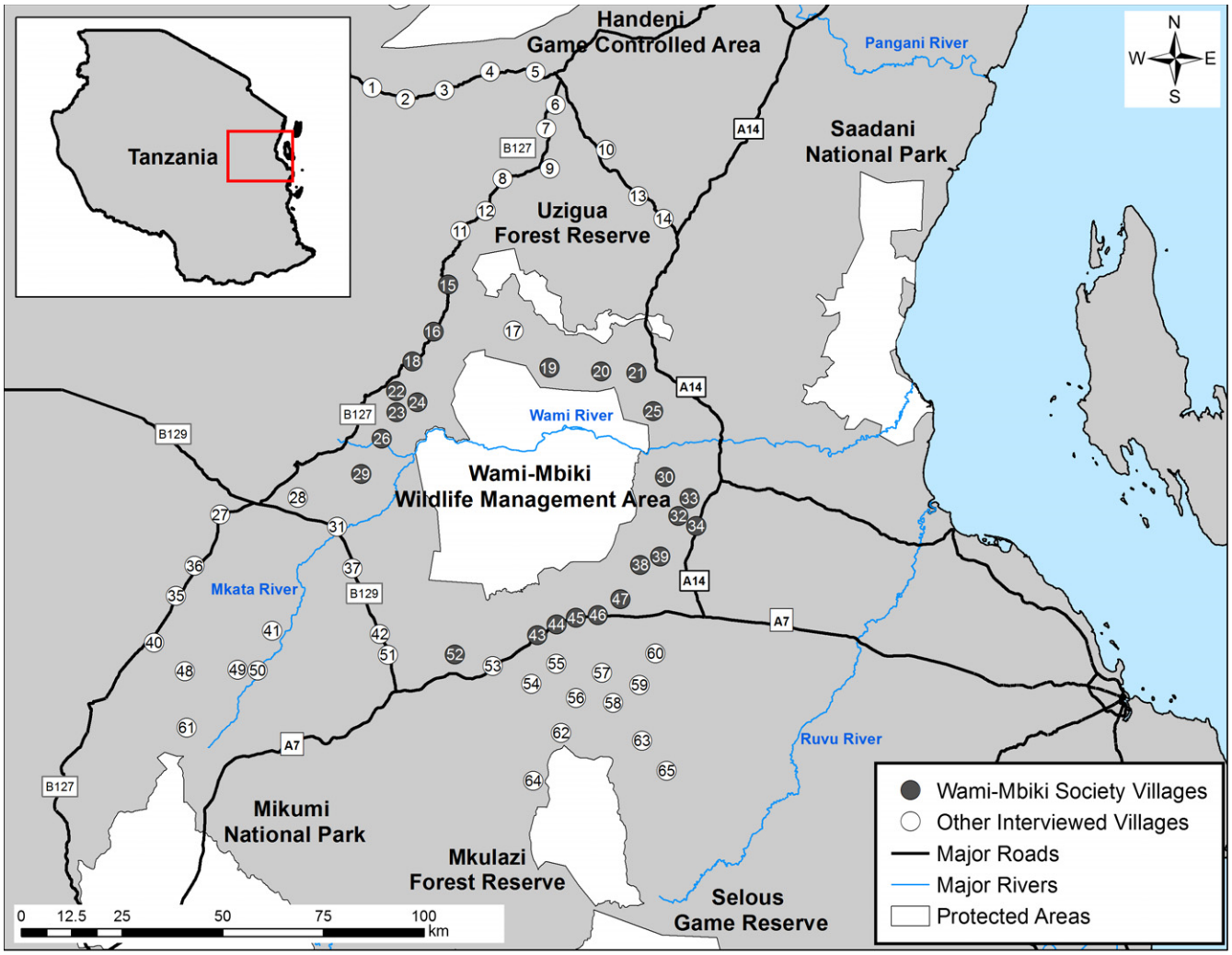

FIGURE 1 Villages around Wami-Mbiki Wildlife Management Area in eastern Tanzania where we conducted interviews concerning wildlife movement. Inset shows the extent of the region in Tanzania. Circles show the location of all 65 interviewed villages, with dark circles representing Wami-Mbiki Society member villages: 1, Kileguru; 2, Muungano; 3, Mswaki; 4, Mafuleta; 5, Kwenkambala; 6, Kideleko; 7, Kwamagome; 8, Kang'ata; 9, Madebe; 10, Muungano B; 11, Negero; 12, Kilimamzinga; 13, Suwa; 14, Mazingara; 15, Mziha; 16, Kanga; 17, Kibindu; 18, Dihinda; 19, Kwamsanja; 20, Kwaruhombo; 21, Kifuleta; 22, Kunke; 23, Kidudwe; 24, Mlumbilo; 25, Pongwe Kiona; 26, Lukenge; 27, Kitete; 28, Milama; 29, Kambala; 30, Pongwe Msungura; 31, Wami-Dakawa; 32, Makombe; 33, Kinzagu; 34, Mindutulieni; 35, Mvumi; 36, Msowero; 37, Wami-Sokoine; 38, Tukamisasa; 39, Diozile; 40, Rudewa Batini; 41, Twatwatwa; 42, Mawasiliano; 43, Maseyu; 44, Gwata Ujembe; 45, Visakazi; 46, Mwidu; 47, Kaloleni; 48, Mbwade; 49, Parakuyo; 50, Mkata Station; 51, Mgulu wa Ndege; 52, Mkono wa Mara; 53, Fulene-Mikese; 54, Muhunga Mkola; 55, Kinonko; 56, Kiwege; 57, Ngerengere; 58, Diguzi; 59, Kidugalo; 60, Kisemo; 61, Ngaite; 62, Mlilingwa; 63, Matuli; 64, Dete; 65, Kwaba

Village Natural Resource Committee or Village Game Scouts (mean number of participants = 3.8, range = 1–9). We first introduced our research to potential participants and gained their consent. Officials participated in the majority of the interviews (n = 42/65). We asked, (a) "Do you think there is a path (corridor) that animals use to move from Wami-Mbiki?," (b) "Where is this path located (show on map)?," (c) "Where do the animals go?," (d) "Which species use this path?," (e) "What time of year do animals use this path?," (f) "Do the animals move across cultivated land?," (g) "How do you know about this path?," and (h) "Do you think this path will disappear? Why?." If the response to the first question was no, we followed up with others including, (i) "Was there a path used by animals?," (j) "Is there something blocking the path of animal movement?," and (k) "When did the path become blocked?."

We held an open discussion between the participants until a consensus was reached for each question and considered all interviewees equally credible. Any mention of contemporary wildlife movement was considered potential corridor-use. Later we overlaid locations of these corridors onto a map of anthropogenic land conversion (GE Grids; Jacobson et al., 2015).

2.3 | Least-cost corridors

We created a cost surface layer of Tanzania using a 0.01° × 0.01° raster data set (projected cell size of ~1 km × 1 km) of anthropogenic land conversion (GE Grids; Jacobson et al., 2015). We assigned cells containing natural lands a cost of "1" to cross, and cells containing converted lands a cost of "10" to cross. This cost

surface layer acts as a simple estimation of the landscape's resistance to large mammal movement.

Using this cost surface, we modelled least-cost paths and corridors (Adriaensen et al., 2003; Pinto & Keitt, 2009) between all protected areas surrounding Wami-Mbiki using Linkage Mapper (McRae & Kavanagh, 2011) to determine locations of continuous connective paths of natural land cover. Corridors were dropped if they intersected another protected area. As a single pixel-wide least-cost path is unlikely to represent wildlife movement properly, we mapped least-cost corridors by selecting the lowest 5% cost cells in the resulting corridor map (Sawyer, Epps, & Brashares, 2011).

3 | RESULTS

Interviews conducted in the member villages of the Wami-Mbiki Society and in the surrounding region uncovered specific villages between which people see wildlife movement (Figure 2; see Figure 1 for names, numbering and locations).

1. *Towards Handeni GCA*: Interviewees noted a corridor running north from Wami-Mbiki into Uzigua Forest Reserve (FR) and beyond towards the Handeni District. This runs through a forested area between Kwaruhombo and Kibindu, surrounding Kwamsanja. Interviewees in both Kibindu and Mziha stated that no corridor exists north of the WMA between their villages. Extensive agriculture blocks animal movement in this area. Land conversion continues south along the B127 highway and includes the Mtibwa teak and sugarcane plantations. All villages interviewed along this route (Mziha, Kanga, Dihinda, Kunke, Mlumbilo and Kidudwe) stated that no corridor remains for wildlife leaving from northwest of Wami-Mbiki. However, all villages noted minor seasonal movements of elephant and/or hippopotamus from the WMA to the flooded agricultural areas to the northwest during the rainy season. Beyond Uzigua, wildlife movements were noted into the forested mountains south of Handeni. All villages along the dirt road linking Handeni west to Kibaya stated that they no longer see animals moving north towards the Handeni GCA, and thus, it appears that the corridor has been severed by land conversion.
2. *Towards Saadani NP via Uzigua FR:* Villagers in Kwaruhombo noted the existence of a corridor to Saadani NP passing north from Wami-Mbiki, through Uzigua FR (along the route described above) continuing east across the A14 highway between Mbwewe and Kwang'andu. However, our interviews in 2014 suggest that the potential corridor described in 2011 (Van de Perre, Adriaensen, Songorwa, & Leirs, 2014) from Uzigua, passing north of Mkata to cross the A14 highway is now likely closed to animal movement.
3. *Towards Saadani NP via the Wami River*: Our interviews in Pongwe Msungura and Pongwe Kiona noted that a second wildlife corridor persists linking Wami-Mbiki and Saadani NP both north and south of the Wami River, between these villages and the river itself. Interviewees in Mindu Tulieni, Makombe and Kinzagu noted no wildlife movements south of Msata crossing the A14 highway. This was also the case for the region between Pongwe Kiona and the dirt road linking Mbwewe and Mziha, with interviewees in both Pongwe Kiona and Kifuleta saying no corridor existed there.
4. *Towards Selous GR*: Interviews in the villages south of Wami-Mbiki noted wildlife movements south from the WMA across the A7 highway towards Selous GR. There appear to be two separate paths. The first crosses the Kitulanghalo FR surrounding Maseyu and animals move between that village and Gwata Ujembe. A second exists between Visakazi and Ubena, around Mwidu village. Importantly both Mkono wa Mara and Mikese said there is no corridor linking Wami-Mbiki south to Selous crossing the sisal plantations between Morogoro and Maseyu. Additionally, as noted in interviews in Kaloleni, Tukamisasa and Diozile, no corridor appears to exist between Ubena and Chalinze, another area with extensive land conversion for agriculture including sisal plantations.
5. *Towards Mikumi NP*: Mkono wa Mara noted a corridor north of the village running southwest from the WMA, crossing the tarmac B129 highway and continuing onwards to Mikumi NP. The three villages along the highway between Morogoro and Dakawa (Mgulu wa Ndege, Mawasiliano and Sokoine) all confirmed the existence of this wildlife corridor through natural lands running from the Wami River in the north, to Mgulu wa Ndege (the interviewee in this village stated that the mountain and land conversion between Mgulu wa Ndege and Morogoro block animal movement to the south). Interviewees in Kidudwe, Lukenge and Kambala also noted wildlife movement between Wami-Mbiki and Mikumi. These villages stated that elephants leave Wami-Mbiki heading southwest along the Wami River and beyond the highway wildlife follow the Mkata River to reach Mikumi NP.

3.1 | Least-cost corridors

The least-cost corridor analysis highlighted five potential corridors connecting Wami-Mbiki to the surrounding protected areas (Figure 2).

4 | DISCUSSION AND RECOMMENDATIONS

4.1 | Wildlife corridors

Using interviews conducted in villages immediately surrounding the Wami-Mbiki core area, our study demonstrates the potential presence of five active wildlife corridors linking the WMA to:

1. Uzigua FR and forested areas in Handeni District to the north.
2. Saadani NP to the east via Uzigua FR.
3. Saadani NP along the Wami River.
4. Selous GR by way of Mkulazi FR to the south.
5. Mikumi NP southeast along the Wami and Mkata Rivers.

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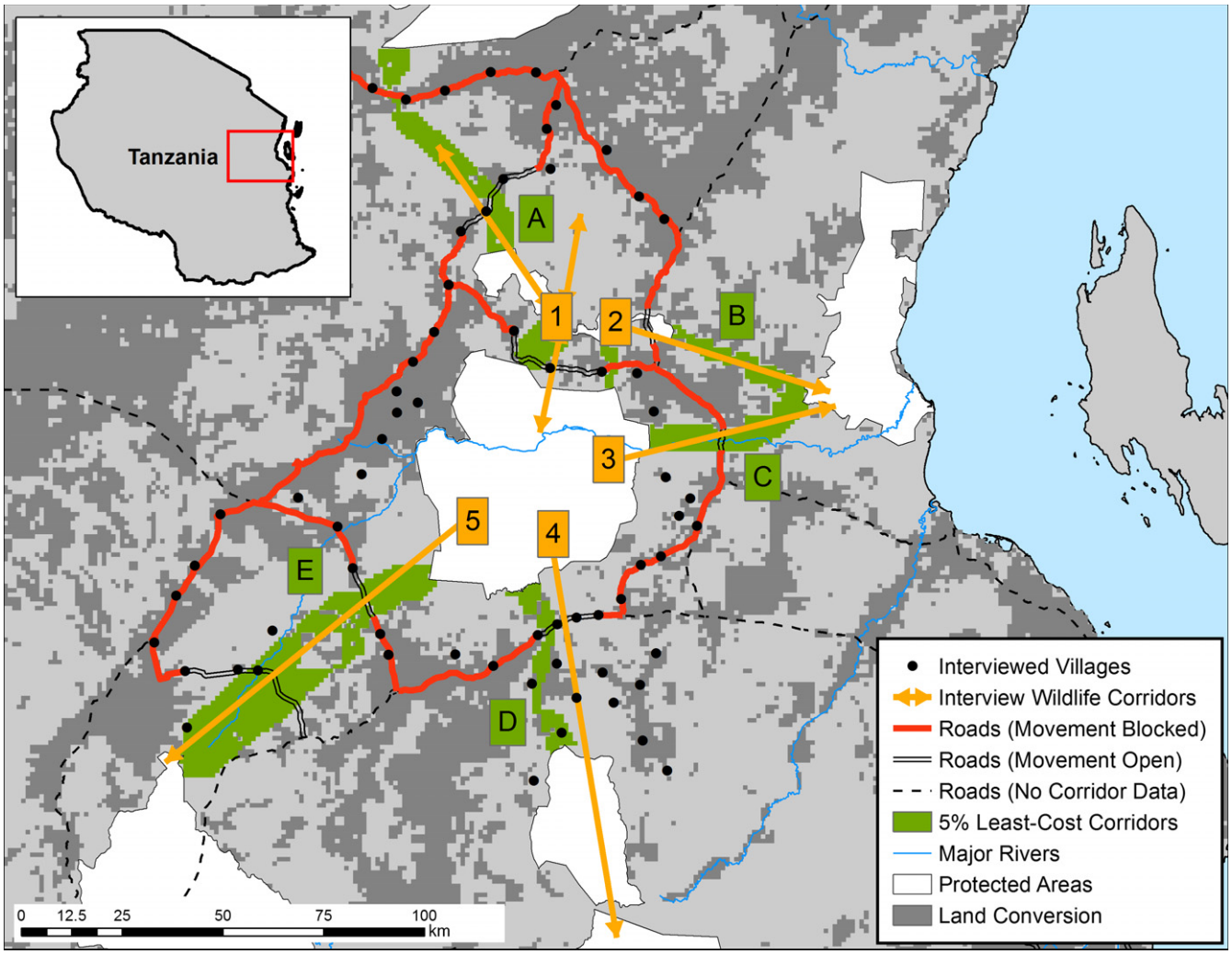

FIGURE 2 The location of wildlife corridors (orange lines with arrows) based on interviews conducted in 65 villages linking Wami-Mbiki WMA to 1) Uzigua FR and forested areas in Handeni District to the north, 2) Saadani NP via Uzigua FR, 3) Saadani NP to the east along the Wami River, 4) Selous GR by way of Mkulazi FR to the south, and 5) Mikumi NP southeast along the Wami and Mkata Rivers. Symbols for roads denote areas where wildlife movement is blocked (solid red), open (hollow) and roads for which we have no corridor data (dashed). The location of least-cost corridors (green polygons) linking Wami-Mbiki to A) Handeni GCA, B) Saadani NP via Uzigua FR, C) Saadani NP via the Wami River, D) Selous GR, and E) Mikumi NP. Dark grey areas represent anthropogenic land conversion (modified from Jacobson et al., 2015; Riggio & Caro, 2017)

We believe that villagers might be prone to denying as corridor (for land use reasons) but would not falsely identify one; thus, our assessment is conservative. Indeed, interviews corroborate both the anecdotal questionnaire data from the national wildlife corridor assessments (Debonnet & Nindi, 2017; Jones et al., 2009), and the systematic quantitative assessment of landscape connectivity across Tanzania (Riggio & Caro, 2017). Importantly, reported paths of animal movement match almost exactly least-cost corridors predicted by the landscape connectivity analysis based on land conversion (Figure 2).

Using TAWIRI's categorization scheme (Caro et al., 2009; Jones et al., 2009), these four wildlife corridors can now be considered type [C], "Continuous or semi-continuous uncultivated land between protected areas with anecdotal information on animal movements." Furthermore, contrary to earlier predictions in which two of the corridors that were ranked in 2009 as having "Extreme" urgency (having <2 years remaining) and two as "Critical" (probably <5 years remaining) (Caro et al., 2009; Jones et al., 2009), all linkages appear intact, with the possible exception of the connection north beyond Uzigua FR to Handeni GCA. We therefore stress that it is not too late to protect these vital connections.

4.2 | Conservation priorities

The Wami-Mbiki WMA itself is under severe threat from agricultural expansion, illegal timber logging, charcoal production and wildlife poaching, due to loss of external funding in 2010 when the Danish Hunters Association (http://www.jaegerforbundet.dk/) ended their financial support. It is surrounded by densely populated cities such

as Dar es Salaam, Morogoro, Bagamoyo and Handeni. Given these threats and the lack of formal protection of the Wami-Mbiki WMA and its surrounding buffer zone, Tanzania risks losing all five corridors, and in turn the final linkage between savannah and miombo biomes in East Africa. We recommend protecting these corridors as well as increasing the conservation measures inside the WMA. The linkages should be recognized as formally protected wildlife corridors, which entails limiting conversion of natural lands to agricultural production, and preventing illegal charcoal and timber production within their boundaries (Debonnet & Nindi, 2017). This is especially important for the current FRs (Mkulazi and Uzigua) that are part of the corridors.

The WMA itself is experiencing a dramatic decline in wildlife due to the incursion of pastoralists and their livestock throughout the area, along with extensive wildlife poaching (Riggio et al., 2018). Steps must be taken to remove these illegal camps, prevent future invasions of livestock and eliminate poaching from the core area. Wami-Mbiki Society's game scouts are committed to protecting the WMA, but are severely hampered by a lack of funding. Without funds for vehicle repair or sustenance, they are unable to conduct patrols or enforce the Society's regulations. Based on our experience, Wami-Mbiki WMA will become inviable without additional funding. We further suggest that the government increases the current wildlife management status to a higher protection level such as "Game Reserve" or "Nature Reserve" or "National Park" and without delay. Although the Wami-Mbiki corridors might be in a more favourable condition than previously thought, we are concerned that this important link between north and south Tanzania will be forgotten.

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