

## **LoRa collars twisting on multiple bull elephants in shrub terrain in Eastern Cape, South Africa**

**Participating Organizations:** Bring The Elephant Home, Kariega Game Reserve, Kariega Foundation, King Mongkut's University of Technology Thonburi, Elephant Reintegration Trust  
**Researchers:** Brooke Friswold, Antoinette Van de Water

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### **Background**

To scientifically test the positive impacts that habitat expansion in private reserves can have on elephant welfare and to further inform the new governmental policy on animal welfare in reserves, Ph.D. Researcher Brooke Friswold along with the NGO Bring The Elephant Home and in collaboration with Kariega Game Reserve, applied XL LoRa (Low Range) elephant radio collars purchased from African Wildlife Tracking (AWT) to three adult bulls and three adult cows prior to a planned fence removal at Kariega Game Reserve in Eastern Cape, South Africa in August of 2022.

### **Terrain**

Kariega Game Reserve is located in the Eastern Cape of South Africa near Kenton On Sea, Grahamstown, and Alexandria. Kariega is a completely fenced, 10,000 hectare private game reserve and is classified as The Albany Thicket Biome. The Albany Thicket Biome is characterized by sparse to dense, spiny, evergreen shrub vegetation. The reserve holds approximately 75 elephants with an internal fence set to be removed in September 2023 to increase habitat availability for all elephants.



## Collared Individuals

Collaring was conducted with a veterinary team (Dr. William Fowls, and Vets Go Wild), a measurement and research team (Bring The Elephant Home and Elephant Reintegration Trust) and a grounds and safety team (Kariega Game Reserve). The elephants were darted from a helicopter and collared while lying on their side. The location of the weight where the collar was sealed which determined the tightness was indicated by the veterinarian and placed based upon considerations of body and neck size, growth over 2.5 years, and neck swelling while in musth (for males). All collars were fitted with a counter weight and applied as directed.

*The collared elephants included:*

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### 1. Kambaku

Sex: Male

Age: 47

Shoulder height: 310

Total body length: 290

Body conditions score: 5

Collar twist: Y



### 2. Kamva

Sex: Male

Age: 22

Shoulder height: 253

Total body length: 280

Body condition score: 4

Collar twist: Y



**3. Balu**

Sex: Male

Age: 20

Shoulder height: 303

Total body length: 278.5

Body condition score: 4

Collar twist: Y



**4. Bukela**

Sex: Female

Age: 51

Shoulder height: 266

Total body length: 251.3

Body condition score: 4

Collar twist: N



**5. Half Moon**

Sex: Female

Age: 28

Shoulder height: 202.5

Total body length: 240.7

Body condition score: 4

Collar twist: N



## 6. Beauty

Sex: Female

Age: 45

Shoulder height: 284.5

Total body length: 265

Body condition score: 5

Collar twist: N



### Twisted collars:

- Two to four days after collar application, Kambaku (the largest and oldest bull) was spotted with a twisted collar. In approximately two weeks, the collar double twisted and at six months it triple twisted. During this time, Kambaku went into musth during which the neck can swell significantly, and thus there was concern that with the twisted collar there would not be sufficient space.

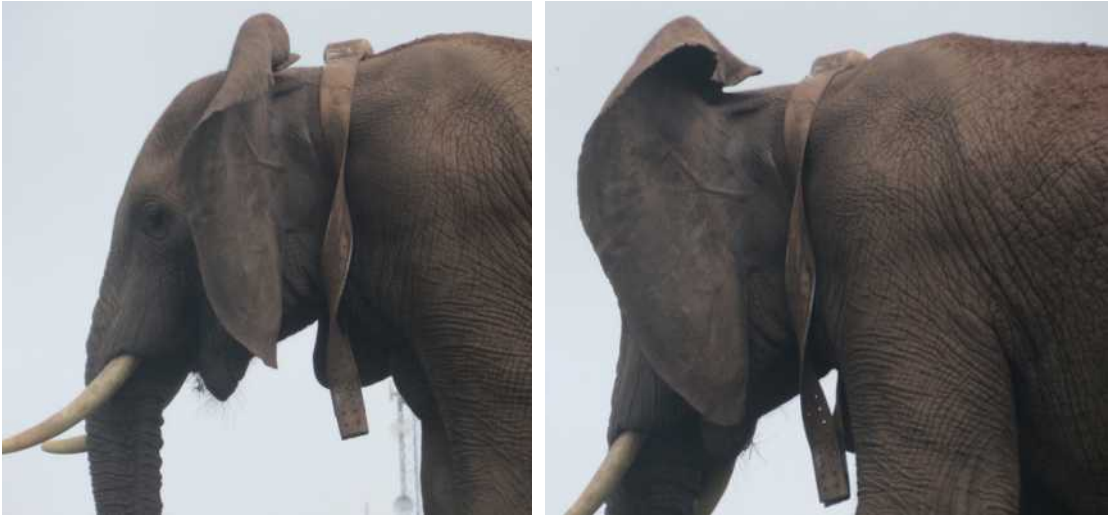


- Five to seven days after application, Balu (young male) was spotted with a twisted collar. In two to three weeks the collar became double twisted and then triple twisted after six months.





Two months after application Kamva (young male) was spotted with a twisted collar. Within six months it was double twisted.



**OUTCOMES**

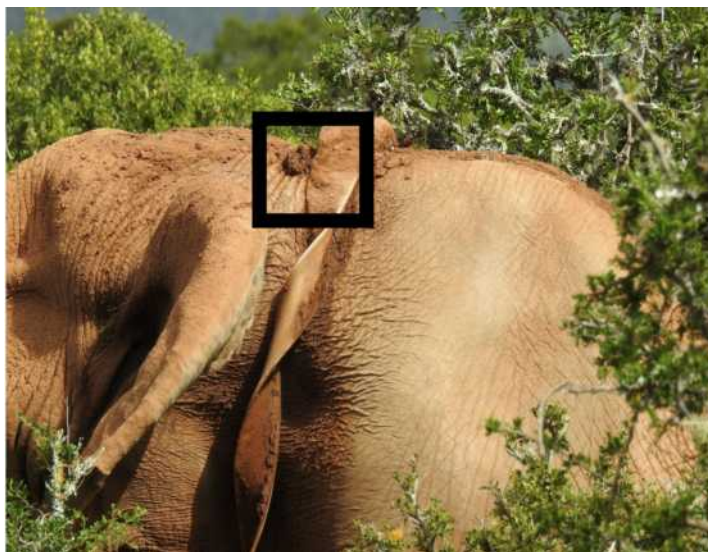
**Collar Removal**

All elephants with twisted collars needed to be monitored regularly to check for any visible irritation to the elephants from the collars (eg. sand dusting and mud packing, touching frequently, head shaking, shoulder shrugging, stress responses etc.). Wounds can develop

underneath the collar or along the collar edge, which cannot always be observed without removing the collar. In other cases, collars have untwisted without intervention so the choice was made to observe the elephants until intervention was needed based on visible and/or behavioral signs of distress with the hope that the collars would untwist eventually and alleviate the issue. Unfortunately, for all three elephants untwisting did not occur after multiple months and it was decided to remove and/or replace all of the twisted collars.

**(Kambaku):** At six months, Kambaku started showing signs of irritation through throwing mud on the collar and shifting his ears continuously. Due to the location of the twist along the neckline and the signs of irritation, it was decided to remove the collar on March 9th 2023.

After collar removal, it was found that mud had also become impacted underneath the collar (see below) which could cause additional issues and discomfort. Audrey Delsink from the Humane Society International - Africa found that in 2% of their AWT collars ulcerations under the collars formed from this. After removal of the collar the material was extremely pliable and had formed into the twisted shape (see below) - further making reapplication, if desired, not possible due to the likelihood of it reforming into that shape and twisting again.



*Location of wound*

**(Kamva)** In April of 2023, three months after twisting, Kamva was sighted with a wound developing on the side of his neck underneath the collar on the left side behind his ear. Based on this, and the extent of the wounds discovered from Kambaku's twists, it was decided to do an emergency intervention to remove the collar on April 21st, 2023. Upon closer inspection of the wounds they were not as deep as Kambaku's, likely due to the fact the collar had only twisted twice and not three times and there was no wound observed on the right side.



*Wound developing under collar prior to removal*



*Collar after removal still holding twisted shape*

**(Balu)** Prior to the intervention Balu had not exhibited any signs of discomfort as Kambaku had, nor any visible wounds seen, as Kamva had. Regardless, it was decided to intervene due to the fact that wound development was highly likely based on the other twisted collars and in the case that a wound could develop, was unseen, or if the collar twisted again could produce issues with tightness around the neck. Meetings with personnel from African Wildlife Tracking were carried out to discuss refurbishment options of Kambaku's removed collar to be reconstructed to reduce the likelihood of twisting. The refurbished collar replaced Balu's twisted collar, so that we could maintain one bull in the study. The refurbished collar that was developed had a wider and thicker belt width (see below for compassion) and different upper unit dimensions in an attempt to prevent twisting.

Table 1: Dimensions of original collar that experienced twisting against refurbished applied to Balu, and a picture of the refurbished collar (right) and original collar (removed from Kamva; left)

	Original collar	Refurbished
<b>Belt width</b>	115mm	120mm
<b>Belt depth</b>	8mm	14mm
<b>Unit length</b>	150mm	190mm
<b>Unit width</b>	150mm	120mm
<b>Unit height</b>	65mm	65mm



The twisted collar was replaced with the refurbished collar on May 10, 2023 as assisted by Kariega Game Reserve, Veterinarian Dr. William Fowldes, and Elephant Reintegration Trust. To our surprise upon removal of the twisted collar, no wounds or abrasions had developed from the triple twist. The new collar was applied slightly tighter than previously and will be removed in a maximum of two years. The new collar will be continually monitored to see if twisting or irritation occurs.

## Impacts

Collar removal occurred for two elephants before fence removal, which is the key event of our comparative study. The likelihood of the collars twisting again if we would have put the collars back on as they were or to have left on with the state of wound development made us decide to leave the collars off for the two elephants and remove Kambaku and Kamva from our study due to the associated welfare concerns. As bulls are trailblazers, and the first in exploring new territory, Kambaku was an especially vital individual in our study design as he is the oldest bull on the reserve and it was decided not to recollar him with a refurbished collar due to his increased age and importance within the elephant social structure of the reserve. The removal of these two key elephants resulted in a loss of 33% of data from the research and will potentially reduce the impacts and significance of the outcomes.

Conducting three additional interventions on these elephants within a six-month period instead of the anticipated three years causes considerable stress on the elephants and surrounding elephants and wildlife within the reserve. The risk associated with each collaring intervention to elephant and human life is considerable for each event, which is weighed by each researcher and organization of the positive implications from the research. The financial cost for elephant interventions is immense; with significant costs and time incurred for helicopters, the refurbished and unusable collars, vet teams, ground safety teams, and transportation for researchers, which all require substantial funding and is considerable for NGO's that rely on grant funding for research.



## INVESTIGATION

### **Considerations on Sex, Terrain, and Behavior**

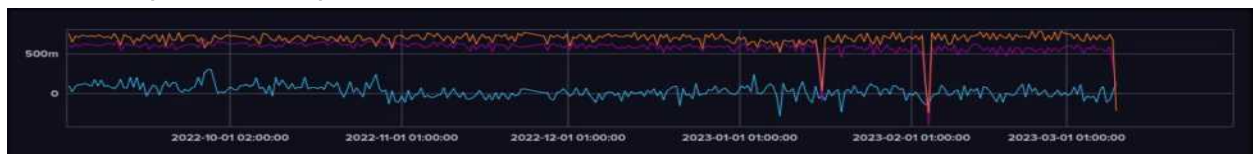
Interestingly, all of the males in the study had their collars twist and none of the females. This may be due to behavioral differences while feeding and moving through dense terrain. Male elephants may be more likely to push through dense vegetation while moving and browsing, whereas a female in a herd may walk around the dense vegetation and be less forceful in moving through it due to the presence of calves in the herd. Bulls pushign thourgh dense vegetation could likely be hooking the upper LoRa unit on a branch and forcing it over if the belt is not thick or wide enough. The spiny Albany Thicket seems particularly suitable for being hooked on a collar as it is highly dense vegetation with many low hanging and strong branches.

### **Considerations on Twisting Locations and Mechanisms**

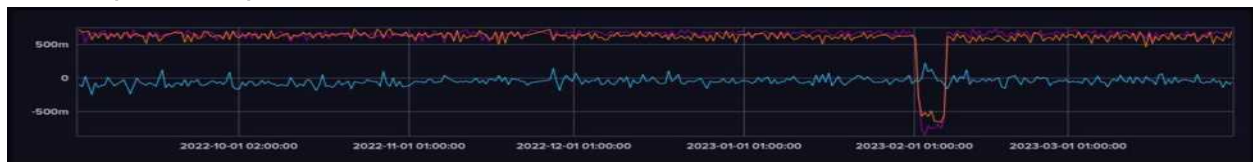
To investigate this further we were able to investigate if the collars were being twisted from the bottom, which would indicate the twisting occurred from elephant manipulation via the trunk, if elephants twist it in this way by playing with the bottom weight the upper unit will likely remain static with the twists coming from below and hanging lower on the elephant's neck. For the upper portion of the unit to "roll" upside down from a below twist would be hard to achieve. A flip occurring from the top unit would likely indicate that it was being pushed over as the elephant moved through dense vegetation, these twists are also potentially more dangerous for the elephant as the nature of the twist occurs higher up on the neck, with the edges of the collar pushing against the skin of the upper neck.

*Using accelerometer data from the collars we were able to determine the exact time of the twists and if they occurred from the upper unit by exploring the unit's frequencies, which will turn negative when the upper unit flips upside down and return positive when it becomes upright again.*

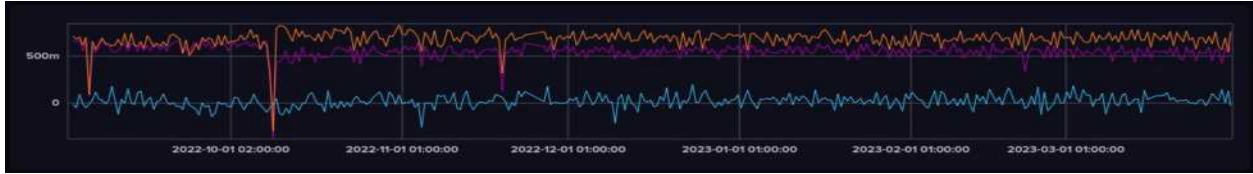
**Kambaku (three twists): all occurred from the upper unit**



**Kamva (one twist): occurred from the upper unit**



**Balu (three twists): all occurred from the upper unit**



The time stamps of the upper unit inversions were then paired with their GPS location. Location points via the collars are taken every 30 minutes so for some there is a small degree of variability with the timing of twisting and thus the location twisting occurred. The points were selected as those closest to the time of the unit flipping but were also compared with the locations before and after the unit flipping occurred.

**Twist locations Kambaku (EB-01)**

*January 14th at 14:36*

*February 4th at 2:20 AM*

*March 9 at 22:30*



**Twist location Kamva (EB-04)**

*February 1 at 19:46*

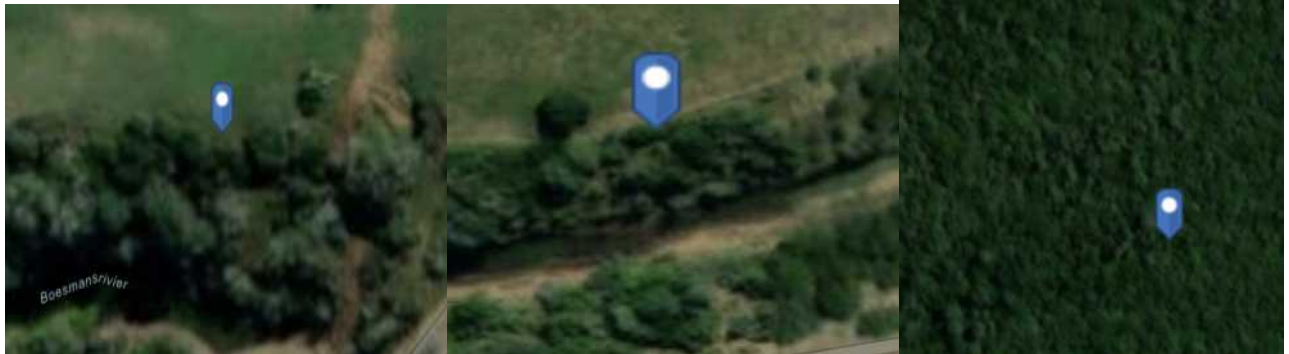


**Twist Balu (EB-05)**

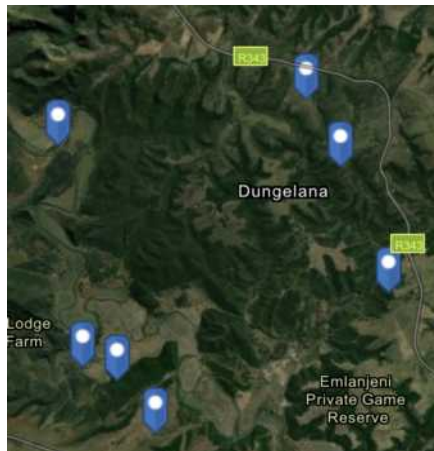
*September 4th at 19:37*

*October 8 at 15:46*

*November 20th at 5:58*



### All twist locations compiled:



All twists except for Kamva's occurred in dense thicket or thicket edges, however, Kamva's twist occurred ten minutes after the GPS data point was collected so we cannot be sure exactly where he was at the moment of twisting which could have occurred in a clump of thicket. All locations aside from Kamva's, strongly indicate a twist was caused by pushing through dense foliage. Kamva's location of twisting occurring in more sparse vegetation includes the possibility of self-twisting or the twisting to have occurred during sparring, although still less likely since an elephant grabbing the collar would result in a pull rather than a twist and the fact that the twist included an upper unit inversion.

The nature of the vegetation at Kariega Game Reserve is very dense. The researchers have witnessed the manner in which bulls move through the thickets and can visualize how branches could have pushed the upper unit resulting in twisting. Due to the fact that the majority of the locations where twisting occurred is inside of dense thicket and that the twisting is occurring at the top of the unit suggests that mostly this is a case of the units catching on branches and being pushed over from the top as suspected.

### Collaring among other organizations

Input from other organizations that have conducted extensive elephant collaring (Elephants Alive, Elephant Reintegration Trust, Humane Society International - Africa, Elephant Specialist Advisory Group) have been consulted on this incident and have all concurred that twisting of this magnitude (50% of elephants in the study) is very uncommon and should be addressed appropriately as this can have serious impacts on elephant fitness, survival, and reproduction.

Elephant Reintegration Trust has collared 15 elephants using AWT GPS collars with only one twisting event. This twist was observed when it happened and was caused by the collar's upper unit catching on the top of the translocation truck when the elephant was loaded. The collar untwisted by itself after one month. They were able to monitor at close range so they could determine if the twist was causing issues.

Elephants Alive (Dr. Michelle Henley) has fitted more than 200 collars to elephants, some of which included the re-collaring of the same individual over time. Elephants Alive primarily used AWT GPS collars. They had only one twisting event out of the 200 collars

applied. The collar was fitted relatively loosely to an adult bull that was still growing and needed the collar space to do so to accommodate the expansion of the neck during musth cycles. When the bull would rest on hot afternoons, he would play with the counter weight of the collar and would pick it up with his trunk and push it through the rest of the collar's loop around his neck which gradually twisted the collar to the extent that the satellite components on the top of the head inverted. The elephant was darted, and the collar untwisted. Only to find that due to the animal's behaviour, he kept twisting his collar. The bull was thus darted again and the collar removed. Elephants Alive were concerned that sores would develop underneath the flipped satellite component of the collar and the battery of the collar would run down as the satellite component was no longer facing skywards. This one incident was due to the elephant's habit of playing with his collar and not due to the manufacturing design of the collar or the terrain.

Humane Society International - Africa (Dr. Audrey Delsink) has collared close to 50 animals (both bulls and cows) also only having worked with GPS collars, both from AWT and Vectronics, and has never had a twisting incident. It is the recommendation of these organizations that the twisting we experienced (50% of elephants studied) is alarming and unusual. It therefore requires an immediate response from AWT concerning LoRa collars on elephant bulls since twisting seems to be much less common with GPS collars - likely due to a difference in shape or to differences in belting width and weight.

### **Post-collaring Monitoring**

Often the ability to regularly monitor elephants post-collaring is not possible and therefore the scope of the problem and the ability to remove or remedy it, is not possible - further risking harm to elephant well-being. Because we had the ability to closely monitor these elephants on a regular basis, we were able to determine that the collars were twisted and/or causing negative impacts to the elephants. Seeing the collars from a far distance or at certain angles could mislead viewers into not seeing the twists since many of them were hidden behind the ear. Dr. William Fowlds reiterated that the twist was not visible from a helicopter when they were monitoring and specifically were looking for twisted collars. He deemed Kambaku's collar untwisted when viewing it from above although it was twisted. It is only visible to view the twists when at close range and when the elephant flaps its ears open, making the scope of this issue likely unknown for multiple organizations that can't monitor collared elephants at close range.

### **LoRa versus GPS**

## **RECOMMENDATIONS**

### **Collar refurbishment**

In discussions with AWT, reviewing photos, and consulting with the veterinarian and support team on the ground during collaring, it was deemed that the application of the collars was placed at the correct tightness considering elephant safety (musth neck swelling, growth over time, etc.). AWT's recommendation is that the weight of the collar is in line with the bottom



of the ear when looked at from the side, which was confirmed by photos, aside from Balu who was determined could have had a slightly tighter collar. Further, the fact that double and triple twists occurred also displays how tightness would not alleviate the twisting issue - as the tightness of the collar increased with each twist and yet they still occurred.

Because collar application was determined to not be the likely cause of twisting, we believe that refurbishment and restructuring of the LoRa collar is needed to fully alleviate the issue of twisting. It is the recommendation of the researchers and participating organizations that these collars should be modified so that twisting of this nature and to this extent is less likely to occur. We believe this could be achieved through:

- A thickened width or denser strap material that is harder to twist, such as the belting used for GPS collars.
- A mechanism that prevents the flipping of the upper unit by increasing it in height (similar to the height of the GPS collars) or attaching a piece at the top to prevent flipping. Conservely the upper unit could be flattened to reduce the risk of catching on branches and being pushed over.
- A mechanism that allows for twisting to also occur at the bottom if it twists at the top so that the twist does not retain permanently and/or cause damage.

Since the LoRa collars are fairly new in their development, it also seems likely that the GPS collars, as opposed to the LoRa collars, are less likely to twist due to subtle changes in its structure. It may then be recommended to develop the LoRa collars to be more similar to the structure and dimensions of the GPS collars.

### **Post collar monitoring and awareness**

Organizations that are conducting collaring procedures, especially those in dense shrub terrains, should be aware that LoRa collars in their current state hold a possibility of twisting, especially with bulls. Further, they should be aware that twisting can lead to wounds that can reduce fitness and survival if no intervention is taken. Conservation biologists and scientists utilizing LoRa collars on elephants should be aware that twisting of collars, especially among bulls inhabiting dense shrub ecosystems, is a possibility and that regular monitoring after collaring to ensure twisting is not occurring is vital and that collar twisting cannot be determined aerially but needs to be viewed from close range on the ground.

### **Investigation**

Collaring issues that could be impacting elephant well-being, such as twisting of collars, or slipping of collar units (as has occurred with HSI-Africa on two occasions) needs to be investigated and mitigated to avoid future animal well-being issues and loss of research efforts. We strongly urge organizations embarking on collaring procedure using LoRa collars to exercise caution and we encourage AWT to investigate this further and inform conservation partners of the possibly of this occurrence when using LoRa collars on elephant bulls.