

Aspects of white rhino movement over a 12-month period based on hourly GPS location data

Felix J Patton^{1*}, Petra E Campbell¹, Angie Genade¹

¹Ziwa Rhino Sanctuary, Nakasongola, Uganda

*corresponding author: rfurhinos@gmail.com

Introduction

Eight female southern white rhinos were monitored by ranger teams at the 64 km² Ziwa Rhino Sanctuary (ZRS), Uganda, 24 hours per day, seven days per week for the year 1 May 2020–30 April 2021. The teams kept the monitored rhinos in view at all times, albeit from a safe distance. In bushier habitat, the rangers would be within 50 metres of the rhinos while in open habitat the rangers could be as much as 150 metres from them. Each ranger team had a smartphone installed with Cybertracker software. These were used to record various details of rhino behaviour including which sector and block the rhino had spent time in, and their GPS location; both on an hourly basis. Such detailed data for free ranging white rhinos has not been published before.

The distance between the GPS locations which changed every two hours represents the positioning made by the ranger team rather than that of the rhinos being monitored but in our opinion is a good representation of the movements of rhinos being monitored. It does not show the distance moved by the rhinos where the ranger did not have to move at all or repositioned just slightly. This occurs when, for example, feeding takes place in a small area with the rhinos slowly moving around but with the ranger remaining in one place.

We recognize that there are gaps in the data collection, for example when the battery of the smartphone failed or where a ranger forgot to enter information. While analysis showed that these technical/human errors were rare, occasionally they impacted all or part of one 12-hour shift.

The ages of the eight rhinos varied from 21 to 7

years: Bella and Kori were estimated to be 21 years/4 months; Malaika 9 years/11 months, Donna and Laloyo 9 years/4 months; Uhuru 7 years/11 months, Waribe 7 years/4 months, Luna 7 years/1 month.

Bella is the mother of Donna and Luna. Kori is the mother of Laloyo and Waribe. Malaika and Uhuru are the offspring of the deceased female Nandi.

Results

Figure 1, a-h, show the 95% home range (convex polygons) and 66% core areas for the eight rhinos. These show a variation from the largest home range of Bella at 41.6 km², core area at 5.4 km² to the smallest of Laloyo at 5.6 km², and a core of 1.1 km².

Table 1 shows the 95% home ranges, 66% being core areas and number of core areas for the eight rhinos. Bella with the largest home range covered some 65% of the sanctuary. Laloyo with the smallest home range covered only 8.8%. The core of Bella is the largest and made up of 12 areas and represented 13% of the home range. Laloyo with the smallest core covered only two areas which represented some 19.6% of her home range.

Table 2 shows the monthly average, daily average and hourly average movement of each of the eight female white rhinos over the 12-month period under study. The average movement of the eight rhinos was 1,707 kilometres (km) over the year, 142 km over a month, 5 km per day and 200 metres per hour. Donna moved the greatest distances at 2,071 km (year), 173 km (month), 6 km (day) and 240 m (hour). Laloyo moved the least distance at 1,311 km (year), 109 km (month), 4 km (day) and 150 m (hour).

Table 3 shows the monthly distance moved for each of the eight female white rhinos by each month, from 1 May 2020 to 30 April 2021. Donna moved the largest distance in any one month at 202 km

Table 1. The 95% home range (HR), 66% core areas and number of cores for eight female rhinos

Rhino	Home range (km ²)	Core area (km ²)	Number of core areas	Home range (%) ^a	Core area (%) ^b
Bella	41.6	5.4	10	65.0	13.0
Kori	29.6	5.2	9	46.0	17.6
Donna	16.4	1.5	2	25.6	9.1
Malaika	9.9	1.7	4	15.5	17.2
Laloyo	5.6	1.1	2	8.8	19.6
Uhuru	9.2	1.5	3	14.4	16.3
Luna	10.3	1.7	3	16.1	16.5
Waribe	7.1	1.4	2	11.1	19.7

(a) HR percentage of total sanctuary area, (b) Core percentage of home range

Table 2. Movement of eight female white rhinos over twelve months, in km

	Year total	Month average	Range	Daily average	Range	Hourly average
Bella	2006	167	142–190	6	2–14	0.23
Kori	1687	141	118–172	5	1–11	0.20
Donna	2071	173	140–202	6	1–15	0.24
Malaika	1759	147	100–169	5	1–10	0.21
Laloyo	1311	109	85–130	4	1–7	0.15
Uhuru	1680	140	110–160	5	1–11	0.20
Luna	1561	130	116–140	4	2–8	0.18
Waribe	1583	132	121–142	4	2–10	0.18

Table 3. Movement of eight female white rhinos by month, 1 May 2020 to 30 April 2021, in km

	Bella	Kori	Donna	Malaika	Laloyo	Uhuru	Luna	Waribe	average	Range
May	185	134	159	149	126	160	125	136	147	125–160
June	179	137	157	153	118	143	138	136	145	118–157
July	184	135	153	161	130	155	138	125	148	125–161
August	163	123	140	156	85	147	125	130	134	85–156
September	142	126	192	140	97	144	121	129	136	97–192
October	150	142	194	144	104	133	139	135	143	104–194
November	159	155	184	157	108	137	126	131	145	108–184
December	161	145	188	169	119	110	135	141	146	110–188
January	190	143	167	151	110	126	136	142	146	110–167
February	144	118	142	100	87	124	122	121	120	87–142
March	171	157	192	148	122	160	140	132	153	122–192
April	179	172	202	128	106	139	116	124	146	106–202
Average	167	141	173	147	109	140	130	132	142	139–134
Lowest	142	118	140	100	85	110	116	121	120	85–140
Highest	190	172	202	169	130	160	140	142	153	130–202
Difference	48	54	62	69	45	51	24	21	33	21–69

while Laloyo at 85 km, the least. The greatest variation between least and most travelled monthly distance was 69 km for Malaika while the smallest variation was for Waribe at 21 km.

Table 4 shows the number of movements over 10 km in one day for each month of the year and the longest movement. Donna moved the most (15) over the most months (9) with the longest single distance in a day of 14.9 km. Laloyo showed no movements over 10 kms with the longest made of 7.2 km, the least travelled distance among the eight females.

Table 5 shows the extent of movement of all eight rhinos in each hour of the day, in kilometres. The data is used to derive that for Table 6 which shows the data represented by

three “intensity” categories—low, medium and high. The most movement was recorded between 7am and 10am and 4pm and 10pm which corresponds with times when rhinos are feeding (see details of the ‘24 hour clock’, Patton et al. 2018).

Table 7 shows the distance moved by each rhino over the year and the size of their home range in the same period and the relationship (proportion) between the two. Laloyo showed the most movement in relation to her home range with Bella moving the least. While Kori and Uhuru moved almost the same distance, Kori had a home range 3.2 times the size of Uhuru. Similarly, Bella had a home range 2.5 times that of Donna while moving only slightly less distance.

Table 4. Number of movements and highest distance over 10 km in one day, by month

Month		Bella	Kori	Donna	Malaika	Laloyo	Uhuru	Luna	Waribe	All
May	number highest									0
June	number highest									0
July	number highest			1 11.5						1
August	number highest	1 11.2								1
September	number highest			2 10.5						2
October	number highest	1 10.2		1 10.8						2
November	number highest	1 10.1	1 10.0	2 11.2						4
December	number highest	1 10.6	1 10.1	1 14.9	1 10.2					4
January	number highest	5 13.9		1 10.5						6
February	number highest			1 11.7						1
March	number highest	1 10.0		2 10.7			1 11.0			4
April	number highest	1 11.6	3 11.0	4 12.6						8
Total	number highest	11 13.9	5 11.0	15 14.9	1 10.2	0 7.2	1 11.0	0 7.5	0 9.8	33

Discussion

One aim of the analysis was to attempt to demonstrate graphically the way a home range (in a relatively small area such as the ZRS at 64 km²) is used/built up over time. This was not achieved

as there were too many data points per month (over 700) within the home ranges. Even when applying the Douglas-Peucker location reduction method (Douglas and Peucker 1973), with the tolerance set at 500 metres, there were still around 90 points. All the rhinos

Table 5: Movement of eight female white rhinos by hour by month, 1 May 2020–30 April 2021, in km

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Average	Range
HOURLY														
24-1	19	25	18	17	14	17	15	17	23	20	23	29	20	14–29
1-2	19	23	14	11	9	18	12	24	16	22	15	23	17	9–24
2-3	16	12	11	10	11	15	12	15	14	19	20	16	14	10–20
3-4	12	13	12	10	10	13	10	11	21	25	20	16	14	10–25
4-5	13	11	8	10	9	11	13	10	23	17	15	27	14	8–27
5-6	16	17	9	17	18	14	21	21	21	16	29	40	20	9–40
6-7	41	35	34	47	69	77	65	62	46	40	74	123	59	34–123
7-8	76	76	74	73	82	90	66	85	78	81	86	115	82	66–115
8-9	104	109	118	121	106	135	135	141	128	95	130	109	119	95–141
9-10	68	67	71	69	66	68	62	78	98	70	114	65	75	62–114
10-11	54	53	57	45	54	44	48	52	64	52	67	50	53	44–67
11-12	35	46	37	30	37	35	37	32	41	28	34	32	35	28–46
12-13	25	32	21	19	30	30	29	23	29	11	21	21	24	11–32
13-14	31	24	28	26	32	35	41	29	18	14	18	44	28	14–44
14-15	44	36	42	43	38	45	45	41	27	14	31	42	37	14–45
15-16	58	53	59	53	52	59	52	45	41	28	48	63	51	28–63
16-17	79	72	80	66	66	83	83	79	65	52	77	88	74	52–88
17-18	91	99	95	84	89	98	125	110	112	90	100	96	99	84–125
18-19	109	111	111	84	90	100	104	101	106	82	98	88	99	82–111
19-20	96	103	101	107	90	95	90	93	113	92	108	97	99	90–113
20-21	88	87	95	74	72	69	76	91	100	72	90	112	86	69–112
21-22	69	72	69	46	54	31	45	63	68	66	76	67	61	31–76
22-23	39	41	31	26	24	25	30	33	41	48	51	38	36	24–51
23-24	34	19	16	20	15	15	18	38	24	19	24	17	22	15–38

Table 6. Intensity of movement categorised for a 24-hour period

START hour	FINISH hour	INTENSITY
23:00	06:00	low
06:00	07:00	medium
07:00	10:00	high
10:00	16:00	medium
16:00	22:00	high
22:00	23:00	medium

Table 7. The relationship between annual distance moved and home range

	Distance moved (km)	Home range (km ²)	Relationship (d/hr)
Laloyo	1311	5.6	234
Waribe	1583	7.1	223
Uhuru	1680	9.2	183
Malaika	1759	9.9	178
Luna	1561	10.3	152
Donna	2071	16.4	126
Kori	1687	29.6	57
Bella	2006	41.6	48

criss-crossed their ranges and went backwards and forwards to favoured areas (such as water points and preferred grazing areas) on a daily basis, preventing any useful graphic illustration of the general direction of travel over time.

However, the monitoring team recorded the sector/block for each rhino—analysed to show the percentage of time each rhino spent in each sector/block on a monthly basis. From this some general observations could be made.

The two oldest females, Bella and Kori, had the largest home ranges with 10 and 9 core areas respectively. Bella had previously shown an apparent aversion to contact with adult males by moving around a large area, 65% of the sanctuary during the year, making it hard for the males to find her. The considered reasons for this are that Bella avoided mating or attempted mating thereby avoiding any potential conflict. This was supported by longer inter-calving intervals than

the other females, (Fig. 1a).

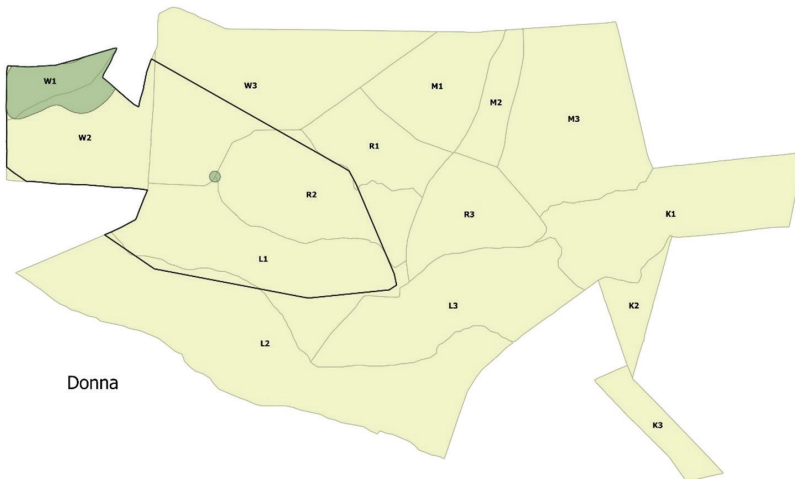
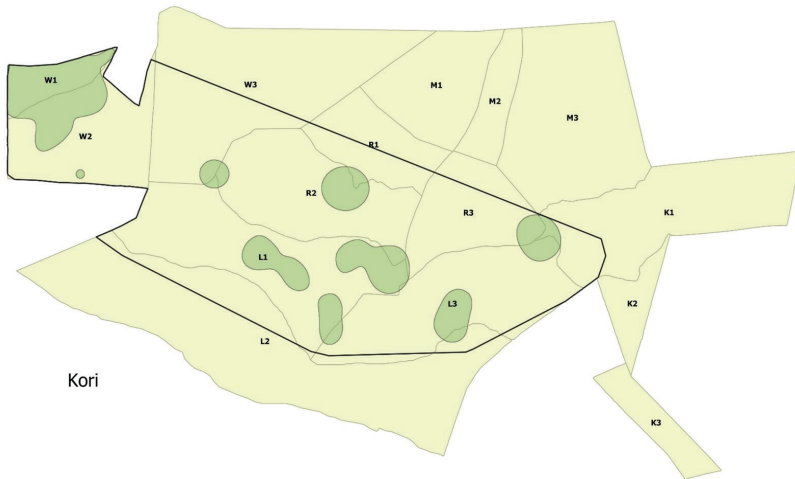
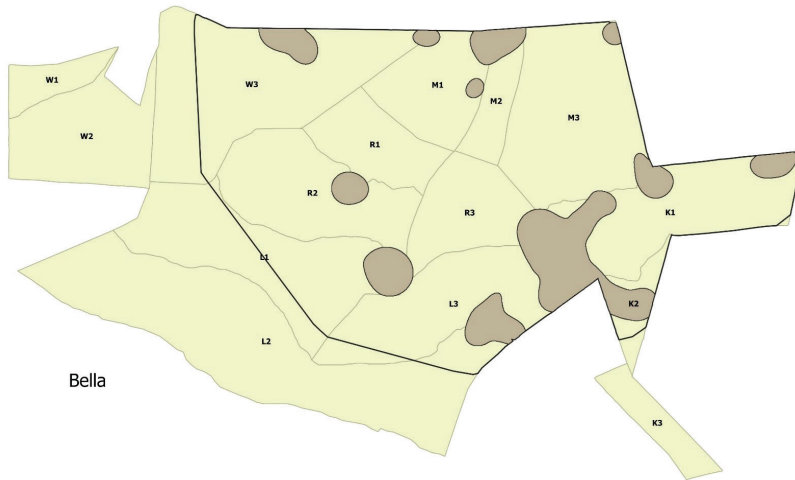
Kori was found mostly in the far west of the sanctuary but started to move across the sanctuary from September 2020 (See Fig 1b). This may have been due to her wanting to avoid the attention of the breeding male Taleo who had fathered five of her seven calves. Taleo was recorded by monitors trying to prevent Kori leaving his territory.

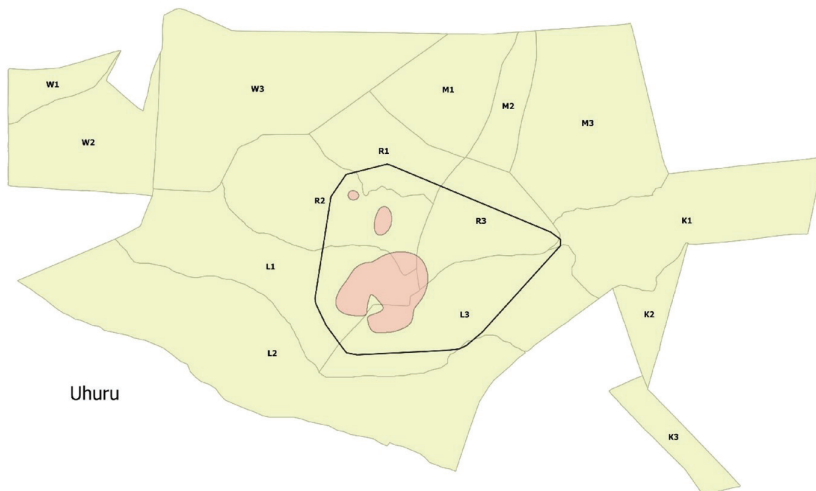
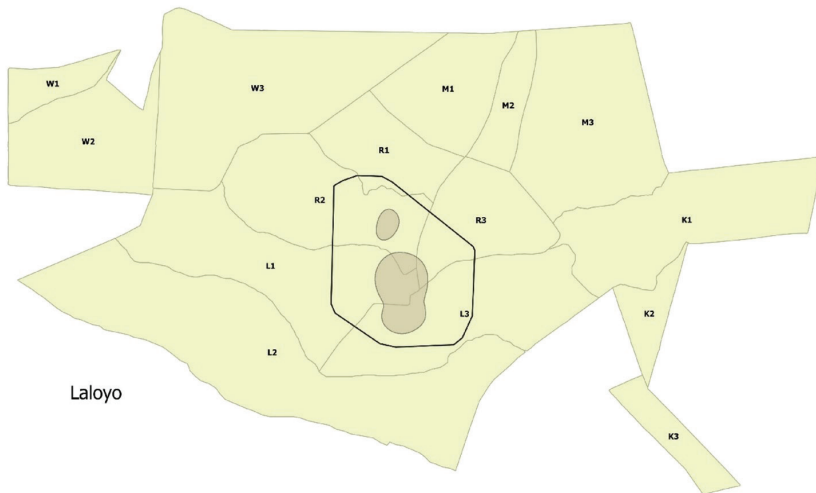
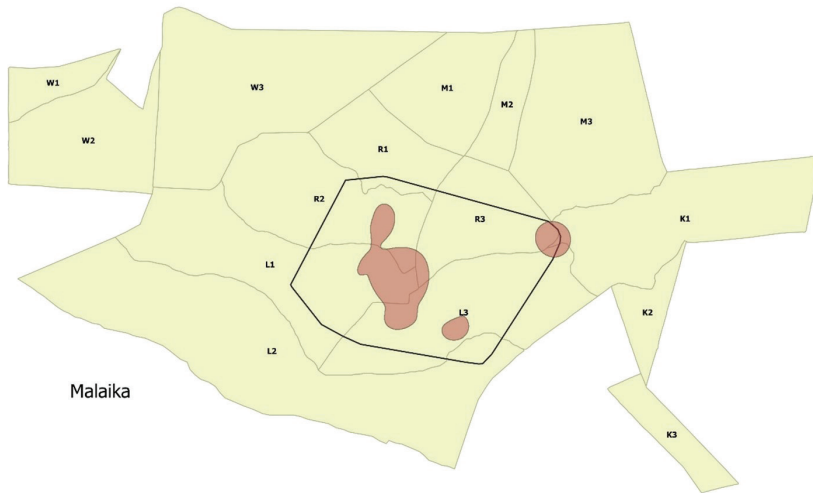
Donna, a younger female, spent her time in the far west of ZWS until February when, during a drought period, she moved into the areas of L1 and R2 where there was a regular water supply, (Fig. 1c).

The other five younger females all maintained their relatively small home ranges which overlapped in the middle of the sanctuary. Throughout the year, they spent most time in an area around the border of L1 and L3 with easy access to water and good grazing.

It might have been expected that rhinos with a larger home range would move a greater distance than those with a smaller range. The analysis of the

Figures a-h:





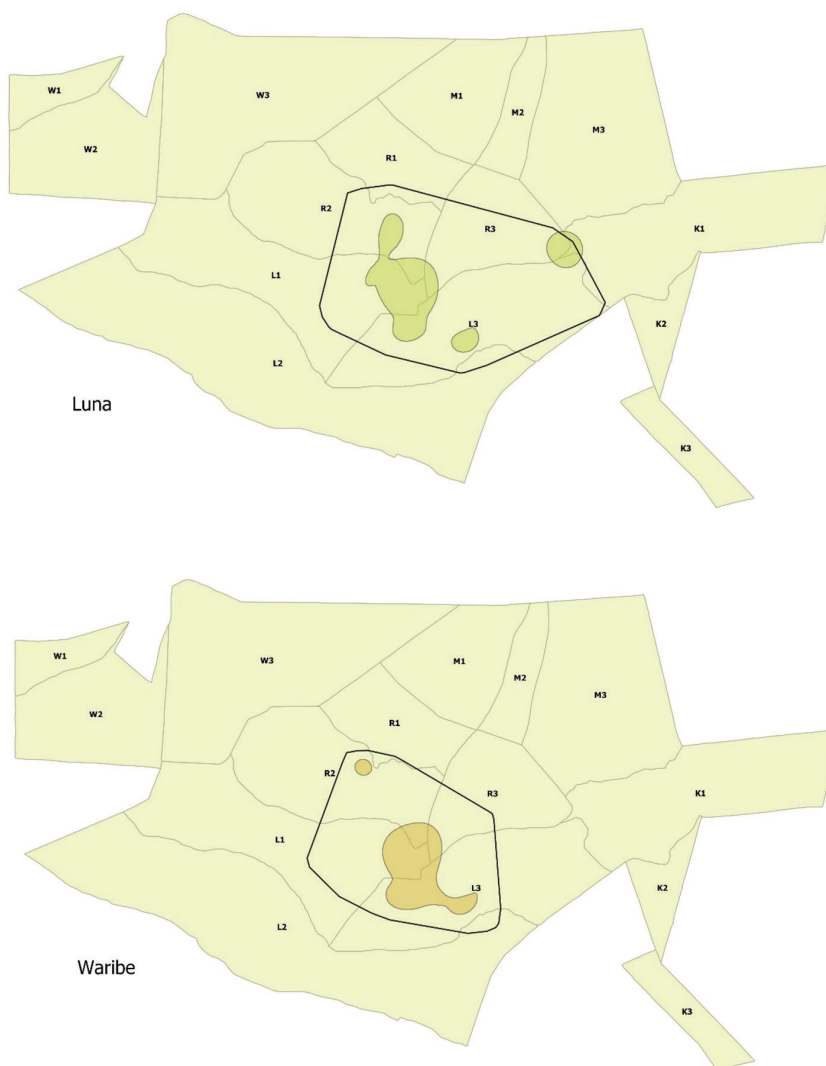


Figure 1. a-h. The 95% home range and 66% core areas of eight female white rhinos for the year 1 May 2020 to 30 April 2021.

(a) **Bella**: home range 41.6 km², core area 5.4 km²; (b) **Kori**: home range 29.6 km², core area 5.2 km²; (c) **Donna**: home range 16.4 km², core area 1.5 km²; (d) **Malaika**: home range 9.9 km², core area 1.7 km²; (e) **Laloyo**: home range 5.6 km², core area 1.1 km²; (f) **Uhuru**: home range 9.2 km², core area 1.5 km²; (g) **Luna**: home range 10.3 km², core area 1.7 km²; (h) **Waribe**: home range 7.1 km², core area 1.4 km².

distance moved compared to the home range area showed there was no such correlation.

A literature search was unable to find any similar hourly-based data for comparison.

References

Patton F, Campbell P, Genade A. 2018.

Observations on the 24-hour clock, reproduction and gestation periods of the white rhinoceros at Ziwa Rhino Sanctuary, Uganda. *Pachyderm* 59: 103–108.

Douglas D and Peucker T. 1973. Algorithms for the reduction of the number of points required to represent a digitized line or its caricature. *The Canadian Cartographer Band* 10, Nr. 2: 112–122.