SPATIO-TEMPORAL CHANGE OF DISPERSAL AREAS OF GREATER KUDU (Tragelaphus strepsiceros) IN LAKE BOGORIA LANDSCAPE, KENYA

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Abstract

Wildlife populations decline of 69% between 1977 and 2016 have been reported in Kenya's rangelands. Baringo County experienced over 85% wildlife loss in the last four decades, and thus a major concern for wildlife conservation, food security and environmental sustainability. Greater Kudu (Tragelaphus strepsiceros) is endemic to Lake Bogoria landscape in Baringo County and constitutes a major tourist attraction for the region. In an area with limited dispersal opportunities, the range for this species is crucial for its survival. To a large extent, extinction of wild animal species has been attributed to habitat degradation that directly affects dispersal areas. This study was carried out to assess spatio-temporal change of dispersal areas of Greater Kudu (GK) in Lake Bogoria landscape in the last four years for enhanced conservation and improved livelihoods. GK population distribution primary data collected in December 2022 and secondary data acquired from LBNR for 2019 and 2020 were digitized using ArcGIS. Measures of dispersion and point pattern analysis (PPA) were used to analyze dispersal of GK population using a Geographic Information System (GIS). It was evident that GK dispersal in LBNR has been changing thus the null hypothesis that spatio-temporal distribution of dispersal areas of the GK in Lake Bogoria landscape did not change in the last four years was rejected. It was recommended that anthropogenic activities contributing to GK habitat degradation be curbed by providing alternative livelihood sources and enhancement of adoption of sustainable technologies including use of solar energy and climate-smart agriculture by local communities.

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Wildlife populations decline of 69% between 1977 and 2016 have been reported in Kenya's rangelands. Baringo County experienced over 85% wildlife loss in the last four decades, and thus a major concern for wildlife conservation, food security and environmental sustainability. Greater Kudu *(Tragelaphus strepsiceros)* is endemic to Lake Bogoria landscape in Baringo County and constitutes a major tourist attraction for the region. In an area with limited dispersal opportunities, the range for this species is crucial for its survival. To a large extent, extinction of wild animal species has been attributed to habitat degradation that directly affects dispersal areas. This study was carried out to assess spatio-temporal change of dispersal

areas of Greater Kudu (GK) in Lake Bogoria landscape in the last four years for enhanced conservation and improved livelihoods. GK population distribution primary data collected in December 2022 and secondary data acquired from LBNR for 2019 and 2020 were digitized using ArcGIS. Measures of dispersion and point pattern analysis (PPA) were used to analyze dispersal of GK population using a Geographic Information System (GIS). It was evident that GK dispersal in LBNR has been changing thus the null hypothesis that spatio-temporal distribution of dispersal areas of the GK in Lake Bogoria landscape did not change in the last four years was rejected. It was recommended that anthropogenic activities contributing to GK habitat degradation be curbed by providing alternative livelihood sources and enhancement of adoption of sustainable technologies including use of solar energy and climate-smart agriculture by local communities.

Key Words: *Spatio-temporal change, dispersal, Greater Kudu (Tragelaphus strepsiceros), Point Pattern Analysis (PPA), GIS*

Highlights

* Point pattern analysis of Greater Kudu dispersal using GIS.

* Spatio-temporal change of Greater Kudu dispersal in LBNR landscape is evident.

* Ecological needs of Greater Kudu affected their dispersal in LBNR landscape.

1.1 Introduction

Globally, an average of 69% decline in the relative abundance of monitored wildlife populations around the world between 1970 and 2018 has been reported [1]. Wildlife populations decline of 68% between 1977 and 2016 have been reported in Kenya's rangelands [2]. The declines have been attributed to rapid growth in human population and associated pressures on resources, institutional and market failures, impacts of climate change and variability, lack of development in the rangelands and ineffective wildlife conservation policies, strategies and practices in Kenya [2, 3]. World Bank report of 2019 listed Baringo County among the few counties in Kenya that experienced over 85% wildlife loss in the last four decades [4]. As one of the most important tourist attractions in Baringo County, there is a growing concern over the future of the Greater Kudu owing to the immense pressure on its habitat that is limited to the Lake Bogoria National Reserve (LBNR) as well as the adjacent farmlands and community grazing lands. The Kudu with its magnificent spiraled horns is one of Africa's most gracious and handsome antelope [5]. Greater Kudu is endemic within Lake Bogoria landscape in Baringo County, in Kenya [6]. Besides being a major tourist attraction for Baringo County necessitating use of its photo on the County's logo and thus a flagship species, its direct and indirect contribution to food and environmental security cannot be underestimated. It is indicated that 92% of all the County's tourists visited LBNR in the year 2017 [7] and thus a huge revenue base.

The Greater Kudu dispersal areas are within the Lake Bogoria Landscape (LBL) that hosts Lake Bogoria National Reserve (LBNR), a World Heritage Site, a Ramsar Site and an Important Bird Area. Lake Bogoria National Reserve (LBNR) is known locally, nationally and regionally, for important wildlife species, including the flamingo and the Greater Kudu. The Reserve has unique physiographic features and geothermal manifestations due to its geological history that portend well for tourism. The combination of landforms, biodiversity content, availability of water and forage makes it a preferred Kudu habitat and an important site at community, national and global levels [6].

Whereas Greater Kudu in IUCN Red List of 2020 is under the category of Least Concern species, it is endangered in Uganda and Somalia and is thought to be vulnerable in Chad and Kenya [8]. Greater Kudu in the Lake Bogoria National Reserve's Integrated Management Plan (IMP) has been listed as threatened and rare [9, 7] and thus the need for consolidated efforts towards its conservation.

The growth in human population in the Lake Bogoria landscape coupled with increased number of livestock and heightened agricultural expansion explains the landscape transformation and to some extent, the observed land degradation in the region [7, 9]. Human-induced changes in an ecosystem may influence spatio-temporal dispersal changes of herbivore wildlife species by affecting forage abundance and nutritional

quality, exposure to predators [10], modification of habitats and breeding areas [11]. Sinclair et al. (2007) found that abiotic events, such as droughts and floods, created disturbances that affected survivorship of ungulates of the Serengeti-Mara Ecosystem [12]. Spatial and temporal heterogeneity in the quality and quantity of food in savanna landscapes affected the distribution of native large herbivore [13].

Understanding spatio-temporal dispersal changes in a landscape will help in evaluating species interaction within their ecosystems and how these interactions are affected by climate and anthropogenic activities [12, 14]. This promotes coexistence of people and wildlife around protected areas, and by extension enhances wildlife conservation, food and environmental security.

It has been demonstrated that in a world with limited dispersal opportunities, the range size occupied by species is crucial for their survival and is responsible for their extinction than any other factor [15]. There is limited information and data on spatio-temporal dispersal changes of Greater Kudu and in LBNR landscape to support management interventions. It is against this background that a study was carried out to assess spatio-temporal change of dispersal areas of Greater Kudu (*Tragelaphus strepsiceros)* in Lake Bogoria landscape in the last four years for enhanced conservation and improved livelihoods.

1.2 Materials and Methods

1.2.1 Study area

Baringo is one of the 47 counties in Kenya. It is situated in the Rift Valley region. Baringo covers an area of 11,015.3 $km^2$of which 165 km^2 is covered by surface water from Lake Baringo, Lake Bogoria, and Lake Kamnarok [7]. Lake Bogoria is the deepest alkaline lake in Kenya with numerous alkaline hot springs that contribute significant inflows into the lake. The Lake Bogoria National Reserve which is 107 km^2 comprises of the lake and the terrestrial portion with various vegetation types depending on soil types and terrain. Lake Bogoria National Game Reserve, lies between 36° 4' and 36deg 7' East and 0deg 20' North and about 10km North of the equator in Baringo County (Figure 1). It has an altitude of between 970m a.s.l at the lake to 1650m a.s.l on Siracho escarpment. The Reserve lies close to the eastern wall of the Great Rift Valley and has its headquarters at Loboi Gate. Lake Bogoria drainage basin has three major soil types; clay soil, clay loam and silt loam. The climate in the plains is arid to semi-arid regimes except in the moist highlands around Subukia. Temperatures around the Lake range from 18^0C to 39^0C with a daily mean of 25^0C. Mean annual precipitation varies from 500-1000mm and falls in two seasons April- May and October- November [7, 9]. According to the population and housing census conducted in 2019, the population of Baringo County was 666,763 showing positive trend [16]. There are six broad vegetation types in the Reserve: riverine forests, wooded bush land, bushed thicket, bush land, bushed grassland and swamps [9].

The area is rich in wildlife species characterized by a high diversity at low densities. Animals found in the plains of LBNR include the Greater Kudu, impala, vervet monkey, dikdik, warthog, and common jackal, among others. There are several reptiles that include monitor lizard, lizards, tortoise, crocodiles and various species of snakes, and over 373 species of birds [7].

Figure 1: The Lake Bogoria National Reserve (Constructed by author using ArcGIS 10.8)

1.2.2 Research design and Data collection

Spatial distribution and dispersal areas of the Kudu were assessed using primary and secondary data of Kudu population count in a Geographic Information System (GIS).

Secondary data that had been collected by LBNR since the year 2019 and data collected during the study period (2022) were used to assess the abundance, distribution and trends of Kudu population for the last four (4) years. The transect lines had been established in the year 2019 by Friends of Nature Bogoria (a regional wildlife conservation organization) with the aim to have Kudu population counts across the year over different seasons.

The distances of the identified Kudus from the already laid out transect lines were recorded and their geographic positions captured using GPS. During the study period, data was collected during the dry (December

to March) season. For temporal analysis, secondary data from LBNR for years 2019 and 2020 for similar seasons (dry) were compared with the primary data. The data for the year 2021 was missing due to travel and activity restrictions associated with Covid-19 pandemic.

1.2.3 Data analysis

The data collected was used to calculate the average density (number/km^2) of Greater Kudu within the landscape during the year 2022. This data was supplemented by historical Kudu population densities according to secondary data acquired from LBNR for year 2019 and 2020.

The presence of Kudus in a location was digitized as points using GIS software. The measures of dispersion and densities were then applied to the distribution data. In addition, Density-based point pattern analysis (PPA) was used to characterize Greater Kudu distribution in the study area in a GIS.

1.3 Results and Discussion

Based on transect line counts, the population of Greater Kudu from 2019 to 2022 is presented in Figure 2.

Figure 2: Greater Kudu numbers over the period 2019 to 2022 at LBNR, Kenya

The population increase of Greater Kudu is attributed to improved conservation campaigns and support by the conservation partners. There was a decrease in numbers in 2020. The decline was attributed to above normal rainfall received in the study area. This may have affected breeding cycle of the Kudus which usually begins at the end of a rainy season or survival rate of the juveniles affected, and/or triggered herbivore migration [17].

The spatial distributions of sighted Kudus for the 3 years are presented in maps (Figures 3, 4 and 5) showing age and sex structured Greater Kudu population for the three years.

According to [18], for the first two weeks after birth, Kudu calf hides where predators cannot find them. It was evident from this study that most of the calves stayed away from the rest of the group since they were still young to move around with the mother (Figures 3, 4 and 4). It was also shown that Kudus were generally concentrated around the Lake. This observation was consistent with the findings of Simpson (1972) that Kudus concentrated around water points during annual dry season [19]. Thus, the sustainability of the Lake is critical for the survival of the Greater Kudu. It is also an indication that there could be limited watering points in the landscape.

Figure 3: *Greater Kudu population (2022) at the LBNR and its environs*

Comparing the three years, most Kudus were counted in the dense vegetation located more than 5km away from the Lake in 2019 (Figure 5). These numbers appear to have decreased over the years such that by the year 2022 (Figure 3), most Kudus occupied areas not far from the lake. This implies that their terrestrial habitat could be facing disturbances from socio-economic activities as was also observed by Aduma et al. (2018) that human activities like agriculture and settlements interfere with migration or dispersal of wildlife [15].

1.3.1 Point Pattern Analysis

It was noted that for the year 2019, Greater Kudu dispersal map shows a density of between 10 and 40 Kudus/km^2 on the rangelands around Maji Moto and Koitumet wards (Figure 6). The depressed rainfall for all the seasons in 2019 contributed to this population pattern. Being shy, the Kudus numbers ranging between 1 and 10 Kudus/km^2 were sparsely spread on the western side of the Lake in the agricultural lands of Molos and Kamar wards. This may lead to Greater Kudu population instability and possibly local extinction due to increase in human-wildlife conflicts. Greater Kudu prefers to inhabit wood and thick bush land, mixed scrub woodland, mopane bush on lowlands, hills and mountains and anywhere with a constant supply of water (20, 21].

Figure 4: *Greater Kudu population (2020) at the LBNR and its environs*

Figure 5: *Greater Kudu population (2019) at the LBNR and its environs*

Figure 6: *Greater Kudu population density (numbers/km2) for Year 2019 at LBNR*

Greater Kudu dispersal map for the year 2020 (Figure 7) shows a density of between 10 and 40 Kudus/km^2 in the leafy vegetation located in Maji Ndege and Chibirebei wards. This could be due to above normal rainfall for all the three seasons of the year (2020) in the landscape; most Kudus met their water needs elsewhere other than the Lake. The Kudus were densely populated in vegetated areas. Socio-economic activities tend to reduce the Kudu population as was evidenced by low numbers ranging between 1 and 10/km^{2}on the western side of the Lake in the agricultural lands of Koitumet and Kamar wards.

The dispersal map for year 2022 shows dense population of Kudus (ranging between 40 and 50/km^2) near the shores of the Lake Bogoria in Koitumet sub-ward (Figure 8). More Kudus were also observed in Chibirebei and Maji Ndege wards in the highly vegetated areas around the Lake. Marginal numbers of Kudus ranging from 1 to 10/km^2 were seen in Tinosiek Olkokwe and Kamar wards, respectively which further affirms the importance of water sources/watering on dispersal of Greater Kudus [13, 19].

Figure 7: *Greater Kudu population density (numbers/km2) for Year 2020 at LBNR*

Figure 8: *Greater Kudu population density (numbers/km2) for Year 2022 at LBNR*

It was evident that ecological needs of Greater Kudu affected their dispersal for instance; water requirements as was indicated by high concentration of Kudus around the Lake shores in the year 2019 when rains were depressed; food as the case for high concentration of Kudus in Chebirebei ward in 2020; breeding behavior as is shown by dispersal of Kudu calves mostly being away from the mature herds; and their seasonal movement patterns or home range. This agrees with what Bennett (2003) indicated as factors to be considered when establishing and managing wildlife corridors [22].

1.4 Conclusion

From the findings on Greater Kudu dispersal in the study area, spatio-temporal changes of Greater Kudu population density was evident thus the null hypothesis that spatio-temporal distribution of dispersal areas of the Greater Kudu in Lake Bogoria landscape did not change in the last four years was rejected. It was recommended that factors contributing to changes in dispersal of Greater Kudu be assessed for enhanced conservation and by extension improved livelihoods in LBNR, Baringo County.

It was also observed that transect lines established in the year 2019 by Friends of Nature Bogoria with the aim conduct annual Kudu population counts are under-utilized. It was recommended that anthropogenic activities contributing to Greater Kudu habitat degradation be curbed by providing alternative livelihood sources, and enhancement of adoption of sustainable technologies including use of solar energy and climate-smart agriculture by the local communities.

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1.7 References

1. WWF. (2022). *Living Planet Report 2022 – Building a nature-positive society.* Almond, R.E.A., Grooten, M., Juffe Bignoli, D. & Petersen, T. (Eds). WWF, Gland, Switzerland.
2. Ogutu, J. O., Piepho, H. P., Said, M. Y., Ojwang, G. O., Njino, L. W., Kifugo, S. C., & Wargute, P. W. (2016). Extreme wildlife declines and concurrent increase in livestock numbers in Kenya: What are the causes? *PloS one, 11* (9), e0163249. https://doi.org/10.1371/journal.pone.0163249
3. Ojwang', G. O., Wargute, P. W., Said, M.Y., Worden, J. S., Davidson, Z., Muruthi, P., Kanga, E., Ihwagi, F., & Okita-Ouma, B. B. (2017). Wildlife migratory corridors and dispersal areas: Kenya rangelands and coastal terrestrial ecosystems. *Government of the Republic of Kenya.*
4. Bank, W. (2019). International telecommunication union, world telecommunication/ICT development report and database, and World Bank estimates. *lamanweb: http://data. worldbank. org/indicator/IT .NET. USER. P , 2 .*
5. Furstenburg, D. (2009). Focus on the kudu (*Tragelaphus strepsiceros*). *S A Hunter, 03026* , 55-59.
6. WWF. (2018). *Living Planet Report - 2018: Aiming Higher.*Grooten, M. and Almond, R.E.A.(Eds). Gland, Switzerland.
7. County Government of Baringo (2018). County Integrated Development Plan for the period 2018-2022. County Government of Baringo.
8. IUCN SSC Antelope Specialist Group, (2020). *Tragelaphus strepsiceros* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2020: e.T22054A166487759. https://dx.doi.org/10.2305/IUCN.UK.2020-1.RLTS.T22054A166487759.en
9. CCB, CCK and WWF. (2007). *Lake Bogoria National Reserve World Ramsar Site (No.1057): 2007-2012 Integrated Management Plan.* Kimunya, M. (ed).
10. Hopcraft, J. G. C., Olff, H., & Sinclair, A. R. E. (2010). Herbivores, resources and risks: alternating regulation along primary environmental gradients in savannas. *Trends in ecology & evolution, 25* (2), 119-128.
11. Burton-Roberts, R., Cordes, L. S., Slotow, R., Vanak, A. T., Thaker, M., Govender, N., & Shannon, G. (2022). Seasonal range fidelity of a megaherbivore in response to environmental change. *Scientific Reports* , *12* (1), 22008.
12. Sinclair, A. R. E., Mduma, S. A., Hopcraft, J. G. C., Fryxell, J. M., Hilborn, R. A. Y., & Thirgood, S. (2007). Long-term ecosystem dynamics in the Serengeti: lessons for conservation.*Conservation Biology, 21* (3), 580-590
13. de Jonge, I. K., Olff, H., Wormmeester, R., & Veldhuis, M. P. (2022). Spatiotemporal habitat use of large African herbivores across a conservation border. *Conservation Science and Practice ,4* (8), e12754.
14. Ogendi, G.M. & Ondieki, R.N. (2020). Avian and Habitat Diversity in the Semi-Arid Lands of Baringo South, Kenya. *Open Journal of Ecology, 10,* 518-536
15. Aduma, M.M., Ouma, G., Said, M.Y., Wayumba, G.O., Omondi, P.A., & Njino, L.W. (2018). Potential impacts of temperature projections on selected large herbivores in savanna ecosystem of Kenya.*American Journal of Climate Change* , *7* (1), 5-26. https://doi.org/10.4236/ajcc.2018.71003
16. Kenya National Bureau of Statistics. (2019). *The 2019 Kenya Population and Housing Census: Population by County and Sub-county* . Kenya National Bureau of Statistics.
17. Owen-Smith, N., (2013). Tragelaphus strepsiceros. In: Kingdon, J. S., & Hoffmann, M. (eds), *The Mammals of Africa. VI. Pigs, Hippopotamuses, Chevrotain, Giraffes, Deer, and Bovids.* Bloomsbury Publishing.
18. Kingdon, J., Butynski, T., & Happold, D. (2013). *Mammals of Africa.* Bloomsbury Publishing. London.
19. Simpson, C. D. (1972). An evaluation of seasonal movement in greater kudu populations- *Tragelaphus strepsiceros* Pallas-in three localities in southern Africa. *African Zoology, 7* (1), 197-205.
20. Yalden, D. W., Largen, M. J., Kock, D., & Hillman, J. C. (1996). Catalogue of the mammals of Ethiopia and Eritrea. 7. Revised checklist, zoogeography and conservation. *Tropical Zoology ,9* (1), 73-164.
21. Tilahun, B., (2019). Ecology and Behavior of Kudu (Lesser and Greater Kudu) in Africa. J*ournal of*

Biodiversity & Endangered Species, **7** (1), 1-5.
22. Bennett, A. F. (2003). *Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation (No. 1)* . IUCN.

Table 1*: Kudu Population Data at Lake Bogoria Landscape for year 2022*

AREA	TIME	GPS LOCATION	TRAN-SECT	HABITAT	GROUP SIZE	SEX	AGE	PER
Kipkoror	8.40am	178287.653E	2	Shrubs	1	M	Adult	50m
		18565.001N	2	Bushland	1	F	Adult	50m
	10.30am	177959.660E	2	Bushland	1	M	Adult	40m
		19133.166N	2	Bushland	2	F	Adult	40m
			2	Bushland	1	Calf	Young	40m
Chepsoyo	8.15am	175179.642E	3	Woodland	1	M	Adult	215m
		37951.396N	3	Bushland	2	M	Adult	175m
	9.30am	175179.639E	3	Bushland	4	F	Adult	175m
		37951.396N	3	Bushland	3	Calf	Young	175m
Tuyarusi	9.15am	168433.550E	4	Bushland	1	M	Adult	258m
		29621.440N	4	Bushland	4	Calves	Young	250m
Ng'orgoin	10.00am	175691.165E	5	Bushland	8	F	Adult	200m
		25570.132N	5	Bushland	5	M	Adult	400m
	10.34am	175356.703E	5	Bushland	4	M	Adult	120m
		26892.196N	5	Bushland	7	F	Adult	180m
	2.14pm	175356.703E	5	Bushland	5	M	Adult	210m
		26892.204N	5	Bushland	12	F	Adult	80m
Long'ang'a	7.15am	180428.013E	6	Shrubs	6	M	Adult	210m
		32360.609N	6	Shrubs	13	F	Adult	150m
Sosiche	6.00am	174025.793E	7	Wetland	1	M	Adult	50m
		34404.781N	7	Wetland	3	F	Adult	50m
	7.20am	174025.798E	7	Wetland	1	M	Adult	100m
		34404.781N						
	11.20am	174025.793E	7	Wetland	1	M	Adult	30m
		34404.784N	7	Wetland	2	F	Adult	30m
				Wetland	1	Calf	Young	30m
				TOTAL	**90**			

Table 2*: Kudu Population Data at Lake Bogoria Landscape for year 2020*

AREA	TIME	GPS	TRANSCECT	HABITAT	GROUP SIZE	SEX	AGE	PERPENDI
Kipkoror	9.30am	172369.224E	1	Woodland	1	F	Adult	70m
		19392.825N	1	Woodland	1	Calf	Young	70m
Chepsoyo	11.02am	175179.642E	1	Escarpment	5	F	Adult	300m
		37951.396N	1	Escarpment	3	Calf	Young	300m
Tuyarusi	7.21am	168433.550E	1	Woodland	1	M	Adult	300m
		29621.440N	1	Woodland	2	F	Adult	240m
	9.30am	168164.861E	2	Shrubland	2	F	Adult	200m
		29806.848N						200m
Ng'orgoin	9.47am	175216.503E	1	Bushland	2	M	Adult	100m
		26892.196N	1	Bushland	4	F	Adult	100m
	10.50am	175216.503E	2	Bushland	1	M	Adult	200m
		26892.196N	2	Bushland	2	F	Adult	200m

AREA	TIME	GPS	TRANSCECT	HABITAT	GROUP SIZE	SEX	AGE	PERPENDI
Long'ang'a	9.00am	180428.013E	1	Escarpment	9	M	Adult	200m
		32360.609N	1	Escarpment	17	F	Adult	200m
Sosiche	9.00am	174025.793E	1	Woodland	1	M	Adult	220m
		34404.781N	1	Woodland	4	F	Adult	220m
			1	Woodland	1	Calf	Young	220m
	10.30am	174025.793E	1	Woodland	1	M	Adult	120m
		34404.781N	1	Woodland	1	F	Adult	120m
				TOTAL	**58**			

Table 3*: Kudu Population Data at Lake Bogoria Landscape for year 2019*

AREA	TIME	GPS	TRANSCECT	HABITAT	GROUP SIZE	SEX	AGE	PERPEND
Kipkoror	9.25am	173517.898E	1	Shrubs	1	F	Adult	30m
		18838.712N					Adult	50m
	10.45am	172369.224E	2	Woodland	1	M	Adult	70m
		19392.825N	2	Woodland	3	F	Adult	70m
			2	Woodland	2	Calf	Young	70m
Chepsoyo	7.30am	175179.642E	1	Woodland	1	M	Adult	115M
		37951.396N	1	Woodland	2	F	Adult	115M
	9.30am		2	Shrubs	1	M	Adult	200M
		175179.650E	2	Shrubs	2	F	Adult	200M
		37951.396N	2	Bushland	2	Calf	Young	200M
Tuyarusi	9.15am	168433.550E	1	Woodland	1	M	Adult	238m
		29621.440N	1	Woodland	3	F	Adult	238m
	10.02am	168164.861E	2	Bushland	1	M	Adult	298m
		29806.848N						
Ng'orgoin	8.25am	175356.703E	1	Woodland	2	M	Adult	252m
		26892.196N	1	Woodland	6	F	Adult	252m
			1	Woodland	2	Calves	Young	252m
	8.50am	175691.165E	2	Bushland	4	M	Adult	217m
		25570.132N	2	Bushland	8	F	Adult	217m
Long'ang'a	9.05am	180428.013E	1	Woodland	10	M	Adult	210m
		32360.609N	1	Woodland	16	F	Adult	210m
	10.00am	180428.013E	2	Shrubs	4	M	Adult	150m
		32360.612N	2	Shrubs	1	F	Adult	150m
			2	Shrubs	1	Calf	Young	150m
Sosiche	9.15am	174025.793E	1	Bushland	2	M	Adult	200m
		34404.781N	1	Bushland	5	F	Adult	200m
	10.22am	174025.793E	2	Woodland	2	F	Adult	150M
		34404.781N						
				TOTAL	**83**