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The Utilization of Water Points by Wildlife Species in Nyae Nyae Conservancy, Namibia

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Abstract

Namibia is a semi-arid country and underground water sources have proven to be reliable water sources for drought-prone countries. Underground water has the ability to sustain conservation activities as long as water infrastructure is in place and maintained. Despite the different water requirements for the wildlife species, water remains an essential component of wildlife management in Namibia. Therefore, this study aims at understanding utilization of water points by various wildlife species in the Nyae Nyae conservancies, which is located in the north-eastern part of Namibia. This study used monitoring data from wildlife counts that are conducted by the Conservancy annually at water points coupled with key-informant interviews with local conservancy members and leaders as well as some stakeholders. The study shows that the Conservancy had a diverse number of wildlife species that were predominantly ungulates (70%). These species were detected at 29 water points distributed across the Conservancy. Most of the water points in the conservancy were artificial points with water drawn from the underground water sources, while a few of the water points were pans (17%). Water resources are very important resources for conservation, not only in terms of being used by wildlife but also in terms of being used to provide an indication of species diversity in the conservation.

Keywords: water points, wildlife, conservation, Nyae Nyae conservancy

1. Introduction

Water is an essential resource for the functioning of ecosystems, habitats and survival of wildlife (Epaphras et al., 2007). According to Pimantel et al. (2004), it is crucial for maintaining an adequate food supply and productive environment for all living organisms. Water resources in southern African countries are unevenly distributed, both spatially and temporally where some countries are extremely dry while others are wetter (Msangi 2014, Heyns 2003). Namibia and Botswana forms part of the driest countries of Southern African with a semi-arid climate that is characterized by low and highly variable rainfall (Bann & Wood, 2012). The average annual rainfall for Namibia is 350mm, ranging from 50mm in the West to 650mm in the North-eastern part of the country. The arid nature of Namibia has also caused water to become a constraint for both human and animals. Equal allocation of fresh water resources between and within the country becomes an issue of concern when looking at this rainfall distribution in the country (Heyns, 2003; Pimantel et al., 2004). In addition to the dry nature of the country its access to permanent or perennial water resources is chiefly along borders with neighbouring countries like Botswana, South Africa, Angola and Zambia (van Vuure, 2011, Heyns, 2003). This has major implications in terms of usage as well as management of water resources in the country.

Given the scarcity of water resources in arid and semi-arid regions, it is important for resource managers to have a clear understanding of the available water and the opportunities possible with the resource. Pimantel et al. (2004) appropriately terms the water required for the maintenance of ecosystem function as “green water”. This “green water” plays great role in the conservation of wildlife through maintaining a productive environment as the availability of water resources dictates species diversity (Epaphras et al., 2007). The availability of green water can also assist in maintaining proper functioning of ecosystem services. Both daily and seasonal migration of wildlife is highly dictated by the availability of water (Jarman, 1972, Wolanski & Gereta, 2001, Western, 1975) including its distribution and functionality in any conservation area (Sungirai & Ngwenya 2016, Epaphras et al., 2007). According to Sungirai & Ngwenya (2016) water shortages have resulted in high dispersal among species and threaten biological diversity. Wildlife in different conservation areas are dependent on various water sources which are either surface water (rivers, dams, lakes) or underground water through boreholes (Douglas-Hamilton, 1973). The distribution of animals are therefore controlled to a certain extent by the availability of surface water which mainly depends on rainfall except in cases where artificial water points are constructed and water supplied from boreholes (Hayward & Hayward, 2012). Artificial water points like these have become the main source of water for wildlife in dry countries (Epaphras et al., 2007). These water points are constructed close to pans and depressions in order to reduce threats to land degradation and enhance better retention of water for wildlife (Sungirai & Ngwenya, 2016). A single borehole can supply water to different artificial water points that are distributed according to the water needs of the area. Given the arid status of Namibia it is clear why underground water would be one of the main water resources even in conservation areas (Bann & Wood, 2012).

Spatial heterogeneity of large herbivores contributes to the quality of operational ecosystems (Ogutu et al., 2010). Abundance and distribution of wild herbivores are important in shaping vegetation structure and quality of ecosystem function and these patterns are influenced by water availability (Ogutu et al., 2010). It is also important to understand how different water points are used by different wildlife species. This is crucial in facilitating the utilization of habitats in order to prevent any negative effects on the surrounding environment. Continuous concentration of animals at water points may cause deterioration of the surrounding vegetation as a result of trampling and over foraging (Ogutu et al., 2010).

The use of water resources by wildlife has been studied in other countries such as RSA and Kenya (Echehardt et al., 2000, Gereta et al., 2000; Epaphras et al., 2007; Tolsma et al., 2007). There is however limited, if any, research of this nature being carried out in Namibia. Namibia as a signatory to the Convention on Biological Diversity is committed to promoting conservation of biodiversity and the sustainable use of its components. Namibia introduced the concept of Community Based Natural Resource Management (CBNRM) over the past decade to allow the involvement of local farmers in the management of natural resources including wildlife (Fabricius & Koch, 2004). The main emphasis of CBNRM is to ultimately give local people rights to management wildlife resources within their areas generating benefits for their livelihoods while at the same time ensuring continued survival of these resources CBNRM is founded on 4 pillars, namely sustainable conservation, economic development, devolution of rights and collective proprietorship (Suich, 2013). The success of the implementation of the CBNRM approach in Namibia has contributed to the increasing community led conservation areas which are currently serving as important corridors between different protected areas for wildlife. In addition this approach represents a unique case where different wildlife species are found outside national parks and game reserves. This study focused on analysing long term monitoring data to determine the use of water points by wildlife species in the Nyae Nyae communal conservancy.

2. Study Area

The study focuses on the Nyae Nyae Conservancy (20ºS, 20ºE), which is located in the communal areas of the Tsumkwe constituency of the Otjozonjupa Region of Namibia.

Figure 1. The map of the Nyae Nyae conservancy and its location in Namibia indicating the water points within the conservancy

The Nyae Nyae Conservancy was registered in 1998 with the Ministry of Environment and Tourism (MET), making it among the first communal conservancies in the country. This Conservancy occurs in the north-eastern part of the country and covers the land under the jurisdiction of the Ju/'hoansi (San) community. The conservancy has an area of 8,992 km^2 (NACSO, 2014) and is characterised by a very low population density as villages outside the Tsumkwe urban settlement comprise of a human population density of less than 1 person/km^2 (Biesele & Hitchcock, 2013).There are approximately 3,000 inhabitants in the conservancy (NACSO, 2010) spread across the 36 villages and the Tsumkwe urban settlement.

The majority of the people in this conservancy are known to have been historically hunter-gatherers, although recently some diversification of livelihoods is practiced (Biesel & Hitchcock, 2013). There is an encroachment of conventional farming methods such as livestock keeping and gardening. The dependence of this community on conservation activities have become very crucial for the livelihoods of the inhabitants through employment and direct benefits (such as game meat, cash and food dividends) (Biesele & Hitchcock, 2013).

The Nyae Nyae Conservancy is located in a dry area where most water sources are boreholes and some dry drainage lines that carry water for very short periods after rainfall. Nyae Nyae conservancy receives summer rainfall (January – February) which ranges between 400 – 500mm (Mendelsohn, 2002). This study area is situated within the Kalahari woodlands consisting of mixed-broad leaved and acacia woodlands (Mendelsohn, 2002; Curtis & Mannheimer, 2005). The dominant tree species in this area include the Terminalia spp, variable different Combretum spp and various Acacia spp (Curtis & Mannheimer, 2005).

3. Methodology

The study used secondary data from annual 48hours wildlife counts in the Nyae Nyae conservancy. This is a monitoring exercise carried out by the conservancy with the assistance of MET (Ministry of Environment and Tourism) and other relevant institutions such as NNDFN, NASCO (Namibian Association for CBNRM Support Organisation) and WWF (World-Wildlife Fund). This data represents annual counts done between 2001 and 2013 at 29 water points found across the conservancy. These counts were all done during the month of September every year during the full moon days. The counts were done simultaneously at all water points where a team of two local trained persons were placed at each water point, recording all species, number of individuals and groups visiting the water points. A database of all annual counts is kept in the conservancy and was acquired with a research permit that was obtained from MET.

The conservancy is divided into districts for the purpose of administration such as local representation in the leadership structures, benefit distribution as well as resource allocations. These districts are not physically demarcated but are rather done by grouping of villages and water points. In some analysis of this study some water points will be analysed based on this district grouping. In addition to this district grouping the conservancy also has a mini-wildlife camp called the Buffalo camp which was constructed to keep the Buffalo from mixing with other species and prevent the increase of foot to mouth disease in the area.

For the purpose of analysis the wildlife species detected during the water point counts (2000-2013) were categorised as large ungulates, small ungulates and predators. The large and small ungulates were distinguished based on the species average body mass by Stuart (2001) where it was indicated that large ungulates weigh between 100kg to over 5000kg where small ungulates weigh between 5-100kg.

4. Results

4.1 Abundance of Species within Conservancy

As seen in Figure 2 the elephant had the highest relative abundance compared to other species recorded at water points and the zebra the lowest. Wildebeest, buffalo, kudu and springbok were also relatively high in abundance at water points within the conservancy.

There was a general increase in the number of water points where wildlife was detected from 2001 and 2013, with the exception of slight decreases observed in these numbers between the years 2001 and 2002, as well as from the year 2007 to 2008 and in the year 2013 as seen in Figure 3. In the same way, water points with no records of species were decreasing over years. The number of water points with wild life records changed over the years, with 13 water points in 2001 and 22 in 2013 although the game counts were done at all 29 water points within the Nyae Nyae conservancy.

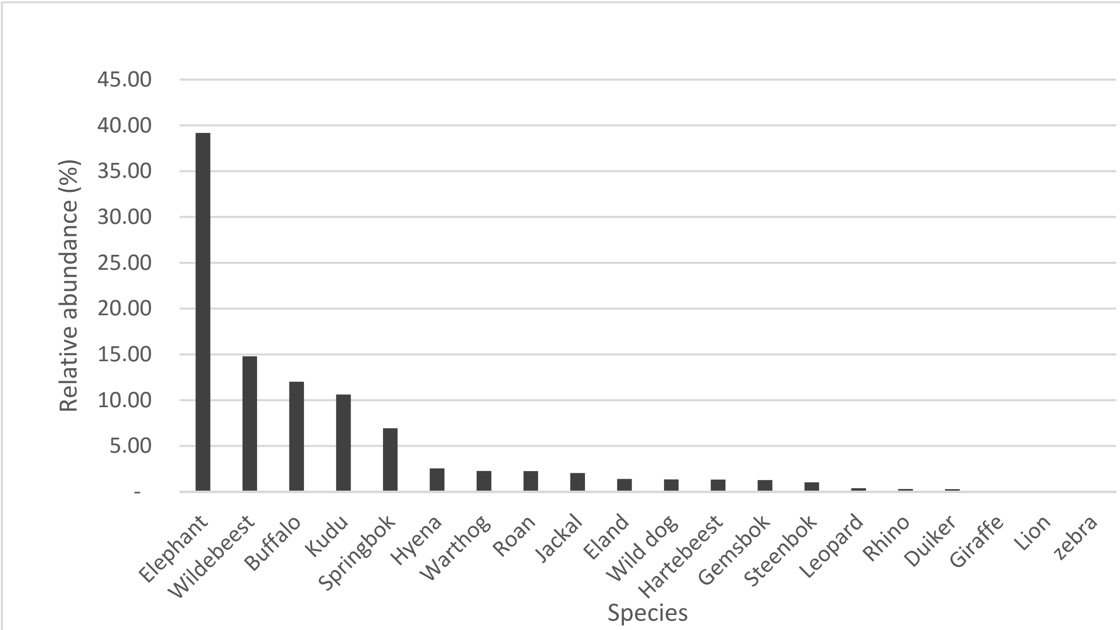

Figure 2. Relative abundance of species visiting water points within Nyae Nyae conservancy

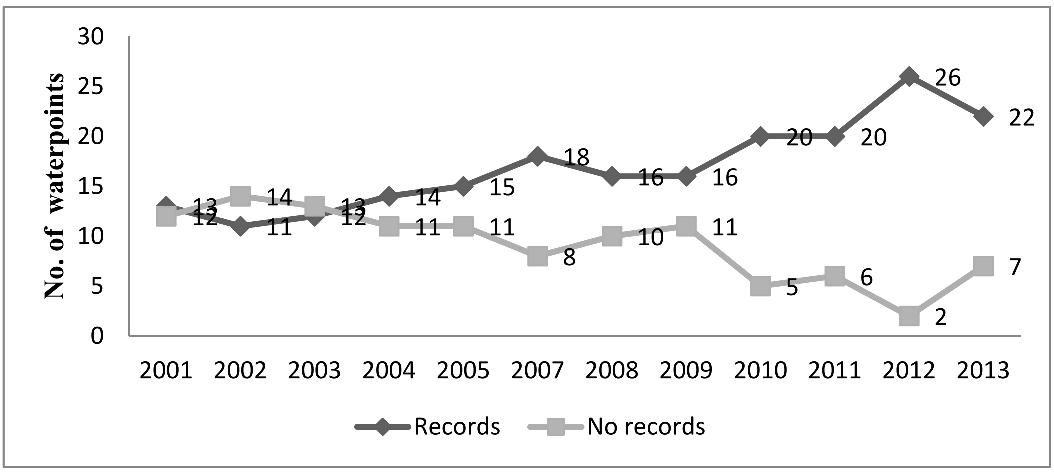

Figure 3. Number of water points where records of visits by animals were made between the years 2001 and 2013

4.3 Species Visiting Different Water Points

Different species visited water points from different parts of the conservancy. Most of the water points attracted between 10 – 17 species (72%) while some were visited by less than 10 species (28%) between 2001 – 2013. The numbers of animals visiting most of the water points between 2001-2013 was not significantly different except for the //Acoach with statistically significance (F=; p=0.003). The number of animals visiting the //Acoach were more or less the same, but a drastic change was witnessed in 2013 when a large number of animals visited the water point (Mean=393.5 and SE=325.7). This high number was attributed by a large group of elephants that visited the water point at once during 2013 due to the drought condition experienced in the area.

Table 1. Table of number of species observed at each water point including the location of the water point within the conservancy and the source of the water between 2001 and 2013

Water point	WP ID	Location	Source	Use of WP	Number of Species	D.f	F-value	P-value	Years recorded
//Achoach	WP1	Central	Pan	game	12	36,51	2.897	0.003	12
//Xaece	WP2	Central	Borehole		15	28, 49	1.325	0.231	12
/Ang!oah	WP3	North	Borehole		7	5, 4	0.268	0.619	2
Baraka	WP4	Central	Borehole	residential	10	20, 23	1.206	0.325	6
Boboha	WP5	South	Borehole	game	8	7, 12	0.599	0.669	5
Boma	WP6	Central	Borehole	game	14	26, 32	1.065	0.4	8
Buffalo 1	WP7	Buffalo	Borehole	game	12	14, 24	0.792	0.647	12
Buffalo 2	WP8	Buffalo	Borehole	game	10	28, 29	0.313	0.979	12
Buffalo 3	WP9	Buffalo	Borehole	game	2	7, 3	1.926	0.208	3
Buffalo 4	WP10	Buffalo	Borehole	game	11	2, 1	1.15	0.363	6
Buffalo 5	WP11	Buffalo	Borehole	game	7	17, 11	0.24	0.867	4
Djxokhoe	WP12	Central	Borehole	residential	11	9, 6	0.449	0.81	6
G/a!oan	WP13	North	Borehole		11	21, 9	1.076	0.395	7
G=aing=oqo	WP14	North	Borehole		14	38, 42	1.16	0.332	11
Gauca	WP15	North	Borehole		7	0., 0	NA	NA	
Grenspos	WP16	Central	Borehole	game	13	5, 27	0.311	0.902	6
Gura	WP17	Central	Pan	game	13	39, 57	0.267	0.99	12
Klein Dobe	WP18	North	Borehole	game	12	26, 28	0.695	0.694	9
Makalani	WP19	North	Borehole	game	6	0, 0	NA	NA	1
Makuri	WP20	Central	Pan	residential	3	0, 0	NA	NA	1
N#ama Pan	WP21	South	Pan	game	9	7, 6	0.18	0.838	3
Nhoma pos 1	WP22	North	Borehole	game	15	22, 51	0.816	0.603	10
Nhoma pos 2	WP23	North	Borehole	game	14	16, 41	0.977	0.465	9
Nyae Khabi	WP24	South	Pan	game	15	23, 33	0.473	0.885	10
Nyae Nyae	WP25	South	Pan	game	17	28, 33	1.351	0.245	8
Pyp	WP26	South	Borehole			0, 0	NA	NA	1
Taragaga	WP27	South	Borehole	game	6	9, 8	0.381	0.852	6
Xamsa	WP28	South	Borehole	game/residential	11	17, 27	1.079	0.402	10
Xinni Xuri	WP29	North	Borehole	game	11	15, 26	0.517	0.851	10

As seen in Table 1, the species visiting water points within the Nyae Nyae conservancy consisted of two groups of ungulates. The ungulates consisted of the large and small ungulates as they were classified according to their mass size. A total of 10 large ungulates and 4 small ungulates were detected at the water points in the conservancy. In terms of the predators five species were detected at various water points of the conservancy.

Table 2. Different classes of species found within the Nyae Nyae conservancy

Classifications	Species
Large ungulates	Buffalo (*S. caffer), e*lephant (*Loxodontus africana), b*lue wildebeest *(Connochaetes taurinus), k*udu (*Tragelaphus strepsiceros), e*land (Taurotragus *oryx),* giraffe (Giraffa *camelopardalis), r*ed hartebeest (Alcelaphus *buselaphus), r*oan (Hippotragus *equinus), o*ryx (*Oryx gazelle), b*lack rhinoceros (Diceros *bicornis).*
Small ungulates	springbok (Antidorcas *marsupialis), w*arthog (Phacochoerus *africanus),* Steenbok (Raphicerus *campestris), d*uiker (Sylvicapra *grimmia),*
Predators	African Wild Dog (Lycaon *pictus), j*ackal (*Canis mesomelas), s*potted hyena (*Crocuta crocuta),* leopard (Panthera *pardus), l*ion (*Penthera leo)*

4.4 Intensity of Utilization of Water Points by Animals

The intensity of utilization of water points by wildlife were different, where some water points were visited by more animals than others. The water points from the different districts that recorded high means of animals were mostly those that operated more years. The water points that had low numbers were among these that did not have wildlife records for every year during the study. These water points might have broken down or had low water yield. In addition, the natural water points in all districts were visited by high mean of animals compared to the artificial water points in the respective districts. Most water points for residential purpose, except Xamsa, tend to be visited by fewer wild animals.

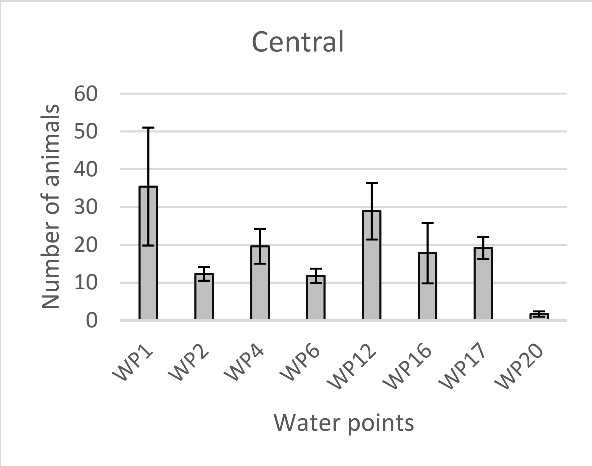

Figure 4. Number of animals observed at water points within the central district

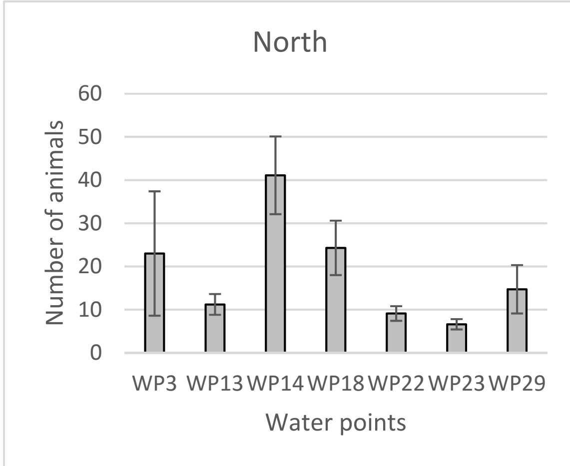

Figure 5. Number of animals observed at water points within northern district

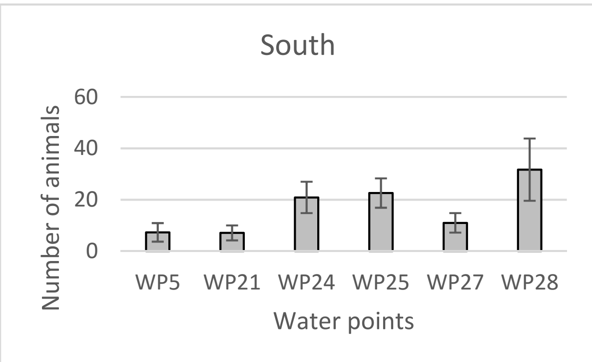

Figure 6. Number of animals observed at water points within southern district

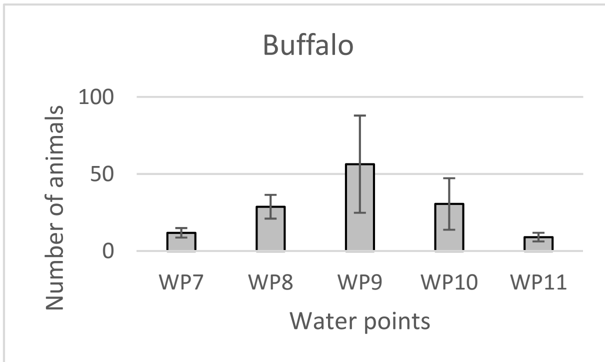

Figure 7. Number of animals observed at water points within the buffalo district

4.5 Locations of Water Points Used by Different Species

Tragelaphus strepsiceros (kudus), *Panthera pardus (leopard) Canis mesomelas (jackal), Lycaon pictus (African wild dog), Raphicerus campestris (steenbok), Sylvicapra grimmia (duiker), Phacochoerus africanus (warthog), Oryx gazella (oryx), Hippotragus equinus (roan), and Connochaetes taurinus (wildebeest)* were found at all water points throughout the conservancy, while *Taurotragus oryx,* (Eland), *Syncerus caffer* (buffalos) and *Diceros bicornis (black rhino)* were only observed at water points within the camp. *Loxodonta africana* (Elephants) and *Crocuta crocuta (spotted hyena)* however, were found in almost all water points, excluding the ones inside the camp. At water points in the South central areas mostly *Alcelaphus buselaphus* (redhartebees) were observed while *Antidorcas marsupialis* (springboks) were observed in south central areas that were closer to the pans. In the North central areas *Giraffa camelopardalis* (giraffes) were observed. Only 2 *Equus burchelli* (burchelli zebra) were observed at 1 water point which was dried out and *Panthera Leo* (lion) were observed in central areas along pans but not within the camp

Table 3. Table showing the areas within the conservancy and the associated vegetation where different species visited water points.

Location	Type of vegetation	Species
Throughout the conservancy	Diverse vegetation	*Tragelaphus strepsiceros (Kudu), Panthera pardus (leopard) Canis mesomelas (jackal), Lycaon pictus (African wild dog), Raphicerus campestris (steenbok), Sylvicapra grimmia (duiker), Phacochoerus africanus (warthog), Oryx gazella (oryx), Hippotragus equinus (roan), Connochaetes taurinus (wildebeest)*
Throughout the conservancy except in camp	Grassland, shrubland, pans	*Loxodonta africana (elephant), Crocuta crocuta (spotted hyena)*
Within the Camp only	Dense woodland and other woodlands	*Syncerus caffer (buffalo), Diceros bicornis (black rhino), Taurotragus oryx (eland)*
Central and North	shrublands, grasslands & other woodlands, pans	*Giraffa camelopardalis (giraffe)*
Central and South	pans, shrublands & grasslands	*Alcelaphus buselaphus (red hartebees)*
Central and Pans	shrublands, grasslands, dense woodlands & other woodlands & pans	*Panthera leo (lion)*
South and Pans	shrublands, grasslands, dense woodlands & other woodlands & pans	*Antidorcas marsupialis (springbok)*

4.6 NDVI Values Throughout 2001-2013

The overall trend of the conservancy was also compared to the NDVI values which is related to the rainfall as it indicates changes in the live green vegetation. It is assumed that the greener the areas, the higher the value and the higher the wetness. There is a clear indication from Figure 8 that the Nyae Nyae conservancy was receiving good values of rainfall over the years, which is an important factor for habitats and wildlife species. When NDVI values were related the wildlife trends between the years 2001 – 2013 (Figures 4-7), there was no particular pattern but perhaps the effects of the rainfall on the counting methods. For instance, high rainfall was experienced in 2006 which led to flooding of most parts of the conservancy and as a result no wildlife count was implemented. In addition, years such as 2010, 2011, 2012 high rainfall was experience and the wildlife populations sighted were low during these years as compared to the good numbers of wildlife populations sighted in 2013 which had poor rainfall or low NDVI values.

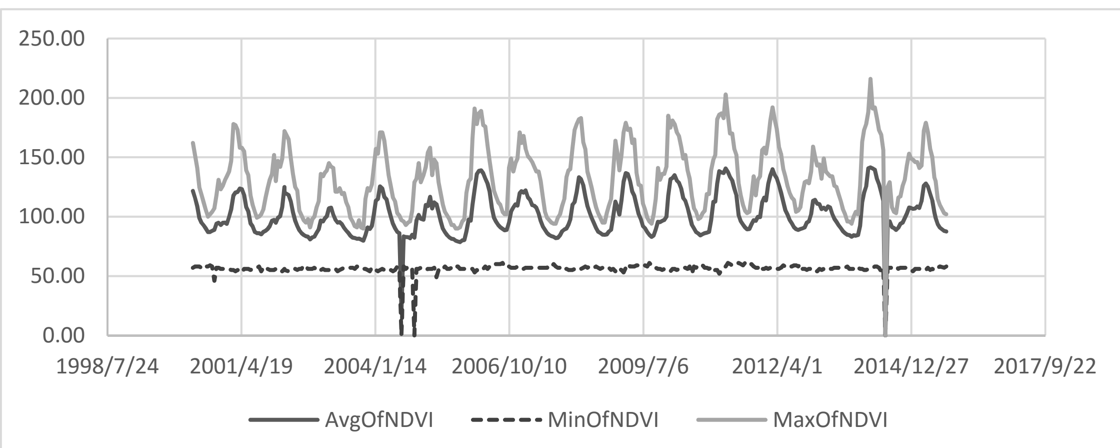

Figure 8. NDVI values for the Nyae Nyae conservancy during the period of 2001 – 2014 indicating the average, minimum and maximum values

5. Discussion

5.1 Number of Water Points Used

The Study shows that the diversity of species visiting some water points was less than others. Water points in the Nyae Nyae Conservancy were either for residential use or for game, although it was expected that wildlife will also visit the residential water points. The water points for human use correspond with the number of villages in the conservancy. However wildlife species were also detected at some village water points like Xamsa, although it was visited less compared to those water points that were solely for game purposes. The absence of species from some water points can be as a result of their built in ability to choose their most comfortable surroundings. According to McMahon & Matter (2006) habitat selection is a crucial attribute for mobile animals. Their ability to avoid or move away from danger or factors that may decrease their chances of survival or reproductive success; or to remain in areas with the appropriate environmental cues is a great adaptive advantage. The distance of the water point from the selected habitat of the species or the presence of other species that may result in possible conflict may influence the animal's decision to visit that water point (Al-Ramamneh et al., 2011).

The decreases observed in the number of water points visited by animals from 2001-2013 may be as a result of drought situations or variability in the availability of water at specific water points resulting in animals not visiting them. According to (Rantanen et al., 2010) resource availability is a factor that influences habitat preference, including where animals prefer to drink. The decrease of the number of water points visited by animals in 2013 (Figure 3) may be as a result a large group of elephants (1368) visiting //Achoach as well as the evident decrease in rainfall during this year as seen in Figure 8. According to Omphile & Powell (2002) numbers of elephant herds observed increase during dry seasons. The reason for this behaviour in elephants may be as a result of decreased availability of water at other points or according to Weir (1972) may also be in response to the presence or absence of environmental sodium. During the dry season elephants prefer drinking in areas that are characterised by the presence of salt licks (Omphile & Powell 2002). Omphile & Powell 2002 explained the reason for this being the lack in nitrogen and phosphorus in their diets during this period that needed to be made up for through nutrient intake from salt licks. The presence of large numbers of elephants may then prevent other species from visiting these water points (Valeix et al., 2007). Other species will shift their temporal niches to avoid interference competition with elephants (Hayward & Hayward 2012). Sungirai & Ngwenya (2016) stated that since elephants are keystone species they have a large influence on the utilisation of water points by other species.

5.2 Intensity of Utilization of Water Points by Animals

The results also show that different water points from each district are preferred differently by animals. Some water points have high traffic of animals while others do not. As a result of the preferential behaviour by different species, different water points will be visited by alternating numbers of individuals. There are many factors that influence an animal's decision to visit a specific water point, including distance from their selected habitat, availability of resources, alternative resources, quality of resource (Sungirai & Ngwenya 2016), interspecific as well as intraspecific competition (Valeix et al., 2007), the vegetation surrounding the water point (Sungirai & Ngwenya 2016, Burger 2001), the mineral availability in the water (Knight 1989) and the presence of predators (Valeix et al., 2009). The intensity of water point use by wildlife was different. Some water points were visited by more animals then others. The water points from the different districts (Figures 4-7) that recorded high means of animals were mostly those that were operational throughout the year and for most of the years. These water points would have been visited by animals every year throughout the study (Xini Xuri, Xamsa, Taragaga, Nyae Nyae, Nyae khabi, Nhoma pos 2). The increase of water points used may also be as a result of an increase in working water points within the conservancy. There was a total of 10 additional water points introduced during the time of the study. The water points that had low means of wildlife may not have had wildlife records for every year like Makalani, Makuri, Buffalo 5, Baboha, Bohma, N#hama pan, Pyp and Grenspos. The reason for this may be that the water points broke down frequently, that they were newly constructed during the study or simply that the water point had low water yield. Some water points were however visited by animals during most or all of the years that the study was conducted. The study shows that the type of water points did not affect the use of wildlife. Despite the fact that natural water sources were fewer in the conservancy they were well utilized. The //Achoach is the only pan in the conservancy that holds water throughout the year even during dry years.

5.3 Location of Water Points Visited by Different Species

In this study Elephants were observed in all districts except within the camp (Table 3). The camp is demarcated by electric fences and deters elephants from attempting to enter explaining their absence within the camp. The study suggests that the general central part of the conservancy is characterised as having few pans and more artificial water points. Artificial water points have more environmental sodium compared to pans, explaining the increased presence of elephants within this district. Distance from water sources influence the distribution of elephants. Although they are able to travel as much as 200km a day in search of water they prefer to stay close to water sources. Resident herds will stay in vicinity of water while migrating herds will travel long distances to find water (Omphile & Powel, 2002). Increased functionality and well planned distribution of water points may prevent herds from migrating, reducing loss in diversity and maintaining ecological balance. Animals make behavioural adjustments to avoid predation. According to Valeix et al. (2009) these adjustments include avoiding risky environments, avoiding periods when predators hunt and avoiding specific vegetation types that may leave them vulnerable. Lions are known to be relatively water independent as they obtain required moisture from the prey they eat (Hayward & Hayward, 2012). The study shows lions in the central districts and around pans. The absence of some herbivore species along pans and central water points can therefore be explained by the presence of lions and other predators. The reason these predators would visit pans opposed to the artificial water points may be as de Boer et al. (2010) stated; to increase chances of successful hunting, as pans are usually surrounded by high grass or woody vegetation offering good stalking grounds for them.

Kudus are known to be mostly browsers and very rarely grazers. According to Annighofer & Schutz (2011) they feed on woody plants during the heat of the day and grasses during early morning hours which are also their time for drinking (Annighofer & Schutz, 2011). The results show a large proportion of the conservancy consists of grasslands including areas adjacent to or in the same vicinity of water points. The widespread availability of water points accompanied by preferential foraging material for kudu may account for the widespread nature of their distribution. According to Mills and Biggs (1993) predators of the kudu include lions, leopards, hyenas and wild dogs. These are all predators present within the conservancy, however Owen-Smith and Mills (2008) describes larger carnivores like leopards and lions as being more dangerous to the kudu.

Regardless of the fact that kudus are natural prey to lions and leopards, they seem to have a widespread distribution overlapping with the distribution of these predators. The reason for the widespread observation of kudus may be as a result of their behavioural attributes. Factors like predation, distance to travel to water points or the presence of other animals that deter other species from visiting specific water points are cancelled out by the increased level of vigilance in kudu adults and the ability of the males to travel long distances allowing alteration in the water points visited during specific time frames. According to van der Meer et al. (2012) predators prefer attacking less vigilant prey, as they are less aware of the attack and have a slower response to it. Kudus, like most other ungulates prefer drinking in areas with little vegetation cover in order to increase visibility of predators. They are disturbed only by hartebeest and zebras and tend to ignore other animals like warthogs, jackal and springbok (Annighofer & Schutz, 2011). Kudus also substitute nutrient intake through foraging with salt licks surrounding water sources (Omphile & Powell, 2002). The widespread distribution and functionality of the water points within the conservancy allows for increased availability of water all over the conservancy especially in habitats favourable for kudus (woodlands and grasslands). In a study conducted by Simpson (1972) Kudus were only distributed over their entire range during rainy seasons, when environmental conditions were optimal. It can therefore be inferred that the widespread distribution of Kudu within the Nyae Nyae conservancy reflect such optimal condition within the conservancy. Since water is a crucial factor in distribution of wildlife species (Epaphras et al., 2007), its role in the pattern of distribution of the kudu within the conservancy -regardless of their water independent status- cannot be under stated. According to Simpson (1972) kudus were seen drinking when water was available and were observed to become relatively water dependent during the dry season when foraging cannot make up for their water needs.

Buffalos are grazers which are known to be relatively water dependent in order to supplement the low water content in grass with frequent drinking (Redfern et al., 2003). A study done by Smit and Grant (2009) showed that buffalo occurred 1.5km from surface water sources while other grazer species occurred approximately 2km from surface water sources. This indicates that buffalos are even more water dependent than other grazing species.

The results show that buffalos were abundant around all 5 of the water points within the camp. Buffalo avoid areas with high risk of predation which reflects their abundance within the camp which serves as a safe zone due to the fact that it is enclosed by fences (De Boer et al., 2010). The confinement of buffalo within the camp prevents them from interacting with their predators. According to Valeix (2009) Buffalos have large home ranges that allow them travel long distances in search of water and forage resources. De Boer et al. (2010) also states that larger animals with larger home rangers can afford to avoid areas where there is potential stress. The presence of functioning and available resources within the camp eliminates the need to travel and maintain the population within the conservancy.

According to Ogutu et al. (2010) Blue wildebeest are distributed independent of water. Variation in rainfall can be associated with shifts in the areas where this species occurred in high densities in response to water availability. These mammals will therefore flock towards areas with high availability of water and away from areas without. The study shows a homogenous distribution of these species which follows a similarly homogenous distribution of water points throughout the conservancy, emphasising the role availability of water plays as a determining factor for species distribution.

Springbok are browsers, they feeds on shrubs and succulents and can live without water for a substantial amount of time, they are therefore water independent (East, 1999). They generally pay no mind to predators because their incredible speed (Richard et al., 1999) and special way of running, known as “pronking” (Cain et al., 2004) make them good at escaping attacks. The only time they are vigilant is during their breeding season. They therefore were observed using water points in areas similar to that of their natural predator, the leopard (Table 3). Springbok meet water needs through their diets, they can survive long periods without water and in some special cases can even go through their entire lifetime without drinking any water but making up for it by eating flowers fruits and seeds before dawn when these items are most succulent (Nagy & Knight, 1994). They are known to seek out water bodies in semi-arid and arid areas like Namibia where variable rainfall can decrease foraging quality and force them to supplement their requirements through drinking regularly. The availability of surface water therefore has an influence on the distribution of these species when they occur in such dry areas. In the years 2002 and 2009 there were high numbers of springbok observed around water points and these years also happened to be years with relatively low wetness according to NDVI value for Nyae Nyae conservancy.

Warthog and wildebeest are known to be water dependent animals (Hayward & Hayward, 2012). The results show that they are distributed all over the conservancy which reflects once again how well distributed and functioning water points can maintain populations.

Available water does not only influence animal distributions, but also shapes the structure and degree of functionality of the ecosystems they are in. Ephemeral pans in alkali flats are suitable sources of water for many animals during rainy season causing them to disperse widely during this time. During the dry season animal concentrations increase in areas with water availability and salt licks, skewing their distribution within the area leading to competition for resources by limiting forage for ungulates with similar diets (omphile & powell, 2002). This increased concentration of animals around specific water points may result in deterioration of habitats surrounding such water points as a result of the heavy traffic of animals foraging and trampling causing soil erosion (Redfern, 1995), overgrazing and local desertification (Ogutu et al., 2010; Gereta et al., 2004, Epaphras, 2007). Smit and Grant (2009) mention induced mortality through starvation that can be caused by degradation of the top herbaceous layer as a result of such overuse. Oguto et al. (2010) and Dudley et al. (2001) also stated that such high densities of animals in one area may promote the spread of disease and other density dependent affects, resulting in increased mortality. Territorial fights between individuals as a result of such density dependent stress may also be responsible for increased mortality according to Mtahiko et al. (2006).

During droughts grazers would have had to alter their distribution to remain close to water resources or travel further for drinking. Wide distribution and high density of artificial water points will supress water scarcity. This distribution also stabilised surface water availability more than is expected in semi-arid rangeland, decreasing variable surface water availability. Spatial and temporal heterogeneity of surface water distribution is important for ecosystem resilience and biodiversity conservation (Smit & Grant, 2009).

Fewer water points results in increased distance to travel when natural water sources are dry, this increased distance is accompanied by increased risk of predation, increased expenditure relative to gain of energy (when animals need to travel long distances between water sources and food sources) (Smit & Grant, 2009), competition for water resources and low quality of available water (Epaphras et al., 2007). Homogenous distribution of artificial water points in relation to natural ones may in this way decrease pressures put on specific water points, allowing for the recovery of the habitat in terms of foraging and regeneration of trampled grass (Epaphras et al., 2007). This increases the quality of the habitat promoting increased and smooth functioning of ecosystem processes. Water is also known to attract wildlife and in the same way maintain them, or keep them in the area. Mtahiko (2006) stated that increased water points in protected areas can prevent migration of wildlife into unprotected areas. For this reason well-functioning and distributed water points within the conservancy may stabilise or even increase species diversity as well as density by helping to maintain wildlife populations within this area, especially of water dependent species.

6. Conclusion

Many studies have pointed out the important influence surface water distribution has on herbivore distribution patterns especially in the case of water dependent species. One of the reasons for its importance is its use as a tool to manipulate the distribution as well as density of certain herbivore species in arid and semi-arid conservation areas.

Nyae Nyae conservancy falls under this classification and is even further characterised by the absence of borders around most of the conservancy except for the border with our neighbour Botswana. This makes the conservancy an open system through which animals are free to roam in and out. In times of distress like drought and water and food shortages response of wildlife would be to migrate to areas with more favourable conditions. The lack of constraint by fences or walls makes this an even more attractive option for animals. There is therefore a need for the conservancy to remain a "favourable" environment for the wildlife populations residing within it to prevent loss of biodiversity through emigration. Populations may decrease in size or emigrate in response to stress created by low quality foraging, increased number of individuals sharing decreasing resources, long distances to resources and some density dependent factors like spread of disease, incest (decreasing genetic variation) and mortality as a result of competition. All these factors can be linked; either directly or indirectly, to the availability, management, utilisation and distribution of surface water sources.

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