Kunene Regional Ecological Analyses: Assisting Conservancies with Seasonal Wildlife Monitoring

2013-14 Progress Report to the

Namibia Ministry of Environment and Tourism

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CONTENTS

ABSTRACT

Round River Conservation Studies working with Anabeb, Ehirovipuka, Omatendeka, Sesfontein, and Torra Conservancies and the Namibia Ministry of Environment and Tourism conducted wildlife surveys in the Kunene Region of northern Namibia. Conservancy Game Guards and Round River completed surveys in the five Kunene Conservancies in Oct-Nov 2011, Mar-Apr 2012, Oct-Nov 2012, Mar-Apr 2013, Oct-Nov 2013, and Mar-Apr 2014; Palmwag Concession was added to the study area and surveyed in Oct-Nov 2012, Mar-Apr 2013, Oct-Nov 2013, and Mar-Apr 2014. Here we report on the results of the last 2 surveys and reference prior surveys and the North-West Annual Game Count (NWGC) to provide temporal trends. The surveys complement the NWGC by providing wildlife count data during other times of the year. The methods employed a sampling design and standardized data collection protocols similar and compatible to the NWGC. In addition to the road-based transects, we also conducted a limited number of point counts in areas remote from roads and road-based transects and remote camera surveys. This report focuses mainly on providing updates to Heinemeyer et al. 2013 report by providing updated population estimates for Gemsbok, Hartmann's Mountain Zebra, Springbok, Kudu, Giraffe and Ostrich. Population densities and abundances are calculated using distance analyses approaches when possible and strip transect analyses when data are too limited to allow the more powerful distance methods. The population estimates are presented for each of the 6 seasonal surveys completed to allow assessment of temporal trends, including regional and Conservancy or Concession-level population densities and abundances. Trends through time are statistically non-significant but may still provide potential insights for management. Most species exhibit a potential negative population response to the drought conditions that have been experienced over the last few years, and some species may show a positive population response to the rains that fell early in 2014. These survey efforts will continue to be repeated each March-April and October-November, and will provide additional species abundance and seasonal distribution information for the Conservancies and the Ministry of Environment and Tourism.

ACKNOWLEDGMENTS

This work could not be completed without the cooperation and support from the Ministry of Environment and Tourism and the Namibia World Wildlife Fund along with the five participating Conservancies and their game guards and community members who assisted during the Oct-Nov 2013 and Mar-Apr 2014 seasons: Anabeb (Willy Ganuseb, Ronald Karutjaiva, Kauhepere Musaso, Ishmael Kaveterua, Linus Mbomboro), Ehirovipuka (Simeon Kakuva, Sacky Utjavari, Once Mukuaruuze), Omatendeka (Nelson Jakurama, Gerson Mukualuza), Sesfontein (Ricky Tjipombo, Pienaar Kasupi, Jackson Uazunga), and Torra (Efraim Awarab, Erick Gewers). In addition, we thank the Round River Conservation Studies Namibia students for their dedication, hard work and good will: Allie Cerretani, Molly Estabrook, Emma Griggs, Wyatt Mayo, Jessica Mohlman, Maddie Norgaard, Kim Oldenborg, Mallory Plummer, Leah Powley, Marina Watowitch and Taylor Wells.

BACKGROUND

Wildlife monitoring in the Kunene Region of Namibia is primarily accomplished through a region-wide annual game count each June jointly conducted by MET, Conservancies and the World Wildlife Fund (WWF). The annual North-West Game Count is the largest road-based game-count in the world covering approximately 6.6 million hectares and over 7,000 km of survey routes (NACSO 2010). For the last ten years, Conservancy, MET and WWF staffs have jointly carried out these game counts in the Conservancies and Concessions of the Kunene region, as well as in Skeleton Coast National Park (NACSO 2010).

To complement and supplement the information on wildlife populations in the Kunene region, Round River Conservation Studies works with MET and 5 Kunene Conservancies to complete additional wildlife surveys in October-November and March-April of each year. These surveys are completed within Anabeb, Ehirovipuka, Omatendeka, Sesfontein and Torra Conservancies and Palmwag Concession (Figure 1) using methods consistent with the annual road-based game counts. The data collection protocols allow for both distance sampling and strip count analyses (Buckland et al. 2001). Conservancy staff and Game Guards are trained in all survey methods and are present on all surveys to enhance and expand their skills and experiences. Game guards are increasingly able to also participate and assist with data processing and management as we continue to provide training in technologies including computer and spreadsheet software use.

We have previously provided annual reports of the on-going wildlife surveys, including complete field methods and data summaries (e.g., Heinemeyer et al 2013). In this report, we do not repeat information provided in prior reports, and request that readers reference these former reports for detailed descriptions of the field and analyses methods. This report presents the new data collected in Oct-Nov 2013 and Mar-Apr 2014, and combines these data and analyses with information from prior years.

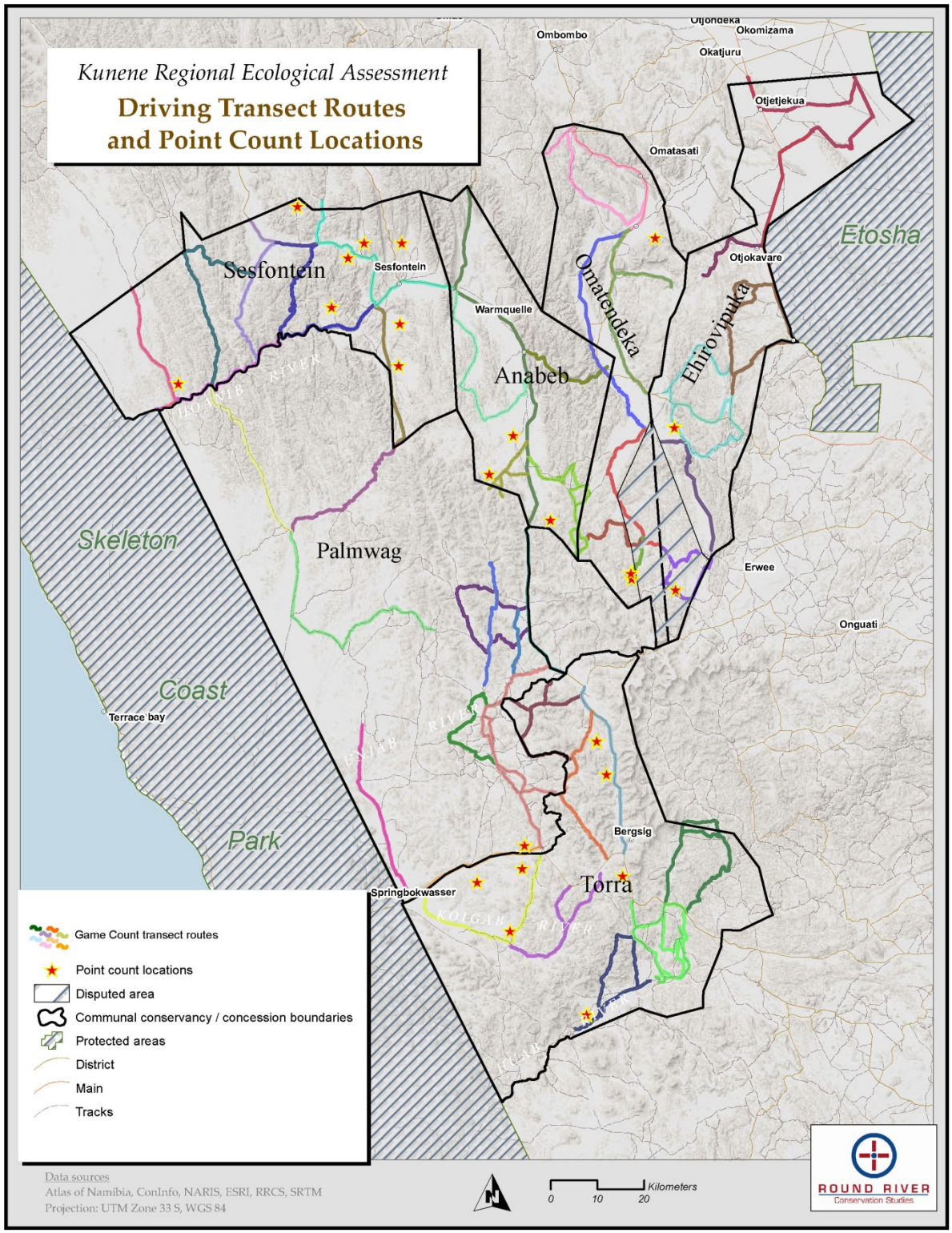

Figure 1. Map showing the road-based game count transect routes and the point count sites surveyed between October 2011 and April 2014 in the Kunene region of northern Namibia.

FIELD EFFORT AND DATA SUMMARY

Road-Based Transect Surveys

In Oct-Nov 2013 and Mar-Apr 2014 we surveyed a total of 1853.6 km and 1809.3 km of transects respectively across the 5 Conservancies and Palmwag Concession (see Appendix I). During the Mar-Apr 2014 surveys, small deviations from the established transects routes were occasionally necessary due to flooding and impassible muddy conditions. See Appendix I for a summary of field effort and synthesis of the wildlife count data across the 6 surveys completed between Oct-Nov 2011 and Mar-Apr 2014.

Summary of Data. In Oct-Nov 2013 and Mar-Apr 2014, we observed 18 and 17 wildlife species, respectively (see Appendix I). This included an observation of 8 black-faced impala in Ehirovipuka Conservancy, a species we have not identified in previous surveys. Other relatively rare observations include an African wildcat, 4 dik diks and a group of 8 cheetah. The most prevalent species were Springbok and Hartmann's Mountain Zebra that were found across all Conservancies and the Palmwag Concession (Table 1, Table 2). Generally, it seems fewer animals were sighted than in prior years across many of the species and this is reflected in lower average counts per transect kilometer in these surveys compared to prior surveys (Appendix I).

Table 1. Total counts of common species observed on vehicular game routes during Oct-Nov 2013.

		Conservancy/Concession (transect distance in km)					
Common Name	**Latin Name**	**Anabeb (205)**	**Ehirovipuka (304)**	**Omatendeka (225)**	**Palmwag (372)**	**Sesfontein (314)**	**Torra (434)**
Chacma baboon	*Papio ursinus*	7	12	0	3	16	37
Gemsbok	*Oryx gazella*	40	65	54	270	97	155
Giraffe	*Giraffa camelopardalis*	26	29	94	64	12	22
HM Zebra	*Equus Zebra hartmannae*	20	153	39	246	61	122
Kudu	*Tragelaphus strepsicerus*	0	9	17	47	7	26
Ostrich	*Struthio camelus*	12	7	7	56	6	90
Springbok	*Antidorcas marsupialis*	329	304	337	546	80	267

Table 2. Total counts of common species observed on vehicular game routes during Mar-Apr 2014.

		Conservancy/Concession (transect distance (km))					
Common Name	**Latin Name**	**Anabeb (163)**	**Ehirovipuka (297)**	**Omatendeka (239)**	**Palmwag (471)**	**Sesfontein (301)**	**Torra (256)**
Chacma baboon	*Papio ursinus*	16	0	0	0	0	33
Gemsbok	*Oryx gazella*	4	11	144	249	70	97
Giraffe	*Giraffa camelopardalis*	3	70	39	36	14	21
HM Zebra	*Equus Zebra hartmannae*	340	17	223	580	168	433
Kudu	*Tragelaphus strepsicerus*	9	8	0	0	0	18
Ostrich	*Struthio camelus*	15	11	9	37	63	23
Springbok	*Antidorcas marsupialis*	352	1	205	2051	934	411

Point-Count Surveys

In Oct-Nov 2013 and Mar-Apr 2014, we conducted 19 point counts each season, for a total of 76 hours of observation time across the 5 Conservancies and Palmwag Concession. During the Mar-Apr 2014 survey season, two new sites were established in Anabeb and Ehirovipuka (Figure 2). Appendix III summarizes the field effort and data collected for the past and current years of survey data collected from Oct 2011 to Apr 2014.

Figure 2. Photograph showing the typical type of point count observation site used to survey wildlife in roadless portions of 5 Conservancies and the Palmwag Concession; this site is in the Anabeb Conservancy.

Remote Camera Surveys

We continue to explore the use of remote cameras as an approach to documenting the presence of rare, cryptic or nocturnal species. In Oct-Nov 2013 and Mar-Apr 2014, 3 sites in Torra Conservancy and Palmwag Concession were monitored for a total of 107 camera trap nights and 108 camera trap nights, respectively. Throughout Oct-Nov 2013 and Mar-Apr 2014, our research team encountered challenges in monitoring the remote cameras. Wildlife species such as hyena, black rhino, and leopard repeatedly disabled the cameras. In Mar-Apr 2014, one of the camera sites experienced an extreme rain event in a short period of time and the camera was lost in the resultant flooding. Appendix IV provides a detailed summary of the effort and results.

Figure 3. One of eight lions (*Panthera leo*) observed at Wereldsend's remote camera station in Mar 2014.

POPULATION ESTIMATES FOR SURVEYS IN OCTOBER-NOVEMBER 2013 AND MARCH-APRIL 2014

A primary goal of the game count survey efforts is to obtain data sufficient to estimate seasonal population sizes for key wildlife species across the region and within Conservancy areas. In this section, we report on analyses to obtain these seasonal population estimates for data collected in 2 survey efforts: Oct-Nov 2013 and Mar-Apr 2014. To provide trend information, we present these results with results from surveys completed in 4 prior seasons: Oct-Nov 2011, Mar-Apr 2012, Oct-Nov 2012 and Mar-Apr 2013.

Methods

We used distance sampling models where possible to estimate regional and Conservancy-level population sizes for Hartmann's Mountain Zebra, Kudu, Gemsbok, Springbok, Giraffe and Ostrich using Distance 6.0 (Thomas et al. 2009). In these cases, the modeling methodologies and considerations were consistent with previous analyses and are described in detail in Heinemeyer et al. 2013 with some small modifications and considerations described below. For each species and season, we evaluated the data sample size requirements, outliers and for violations of major assumptions regarding the expected shape of the data distribution, evaluated the fit of multiple models to select the best function for each species and season of data, and used distance analyses to calculate density. In cases of sample size limitations or where we were unable to fit an appropriate key function at the regional or Conservancy-level, we use strip transect analyses to provide an approximate estimate of density and population size. Details of this methodology are below.

In addition to providing our analyses based on the surveys we have completed, in some Figures we have also shown population estimated from the North-West Game Count (NWGC) for comparison purposes. The NWGC represents the primary population monitoring effort for the region and providing our results in context with these seems appropriate and potentially helpful. The study area extents of the 2 efforts overlap but the NWGC covers a much more extensive area including several additional Conservancies and Concession areas. Thus, to provide relevant data from this larger effort, we used the NWGC Conservancy and Concession-specific strip transect population estimates available annually on posters (available at www.nasco.org.na). We summed these area-specific estimates to provide a comparable regional estimate that matches our regional estimates in space. The NWGC information available for June 2011, 2012 and 2013 has been included in relevant figures; the June 2014 results were not available at the time of this report.

ADDITIONAL FACTORS TAKEN INTO DISTANCE-BASED POPULATION ESTIMATES

Sightability of species is likely to decline with increasing distance from the transect line and may result in unreliable data at far distances and biases towards sighting only larger group sizes at longer distances. We used regression to test for group sizes differences by distance and used the expected group size in the analyses based on the regression results. This differs from previous analyses, which tested for differences between the average cluster size and the expected cluster size and used expected cluster size only when the difference was significant at a $p<0.85$ level. Our current approach is more conservative in that it avoids any inflation in modeled group size due to biases possible in sighting only larger groups of animals at greater distances. We evaluated the

predicted population size differences between the 2 approaches and found them to be small (<4%) and therefore have not re-analyzed prior data.

To maintain consistency with the methods of the NWGC, we calculated estimated population size based on the hectares within each Conservancy and the Concession that are used in the NWGC analyses. These estimates remove areas that are far from transect routes to avoid extrapolating into areas that are not surveyed. The resulting population estimates assume these remote areas do not support the species under consideration. This is a conservative measure due to the under sampling of these areas and does not suggest the excluded areas do not support wildlife but that these areas are not sufficiently sampled. This is consistent with how population sizes were estimated previously and presented in Heinemeyer et al. 2013.

Strip Transect Population Estimates

There is inherently high uncertainty in population density and size estimates calculated for species with regionally low numbers or for individual Conservancies where sample sizes are low. We selected 1 of 2 potential approaches for estimating population densities and sizes in these situations. If assumptions about the data appear to be reasonable (though sample size is low) and the key function and model are fit with a percent coefficient of variation (%CV) $\leq$50%, we present the distance-based model results. In most cases, this is true for regional population estimates where we pool data across surveys for the season under consideration. In a few instances such as Kudu in Mar-Apr 2014, data are so limited that we use strip transect analyses even for regional population estimates. If the %CV was greater than 50%, we concluded the model results were potentially unreliable and we calculated the population estimate through strip transect analysis.

For the strip transect analysis, we used Distance 6.0 to evaluate the data distribution and calculate the global 'estimated strip width' (ESW) which is the estimated half width of the strip transect which would be expected to have all the animals included in the analyses (e.g., all animals within 1000m or other truncation distances). Note that ESW and 'truncation distances' are defined differently. Truncation distances reduce the number of animals included in any analyses based on their distance to the transect line; this improves data reliability as the accuracy of counts of animals far from the transect line becomes suspect. The ESW uses the distribution of these animals to assess the number of animals missed at increasing distances to provide an estimate of the width of the strip transect that would contain these animals *if no animals were missed*. For additional description of the ESW, see Buckland et al. (2001).

Using the ESW, we estimated the area surveyed as:

Survey Area: 2ESW x total transect length

for each Conservancy (or region, as indicated by desired analysis). We divided the number of animals included in the analysis by this area to estimate density as number/hectare. We had not used this approach in Heinemeyer et al. 2013. To allow comparisons across surveys, we implemented this analysis for all Conservancy data from Oct 2011 to Apr 2014 that had distance-based modeling results that did not meet our minimum requirements (i.e., %CV>0.50), resulting in some estimated population sizes changing from those reported in Heinemeyer et al. 2013.

Results and Discussion

We used distance-based analyses to calculate population estimates for 5 species (Gemsbok, Zebra, Springbok, Giraffe, and Ostrich) across the study area, with estimates calculated for each of the 2 surveys. Data were marginal to undertake distance-based population estimates for Kudu from the Oct-Nov 2013 survey and we provide this with caution. Data were insufficient to complete distance-based analyses on Kudu from data in Mar-Apr 2014 and we provide strip transect analyses to provide an approximate estimate for the Kudu in Mar-Apr 2014.

We present the results in tables and figures with prior survey analyses results to provide trend information. In Oct 2012 our sampling area expanded to include the Palmwag Concession. To take advantage of surveys completed prior to this expansion, we provide two estimates: population information within the 5 Conservancies only and population information within both the Conservancy and Concession areas.

Conservancy-level population estimates proved challenging due to relatively small sample sizes and we again urge caution in interpreting the results. Our ability to fit a suitable distance-based model for population estimation can vary based on date for each season and species. Methods used for each species, season and Conservancy are summarized in Appendix II. If 2 surveys were completed within a calendar year (i.e., 2012 and 2013), we present the average of the two estimates regardless of the underlying calculation method.

Gemsbok

Gemsbok observed within 1200m of the transect line were included in the modeling and analyses. A summary of relevant survey information and modeling parameters can be found in Appendix II. Total numbers of individuals seen in the 5 Conservancies dropped to 398 and 326 in Oct-Nov 2013 and Mar-Apr 2014, respectively down from a high of 951 animals seen in Mar-Apr 2012 (Table 3). Including Palmwag Concession increased the number of individuals but these last 2 surveys still had the lowest recorded numbers found in our survey efforts (Table 4).

Gemsbok density across the region reached its lowest estimate in Mar-Apr 2014 at 0.0024 animals/ha (0.0017 estimated without Palmwag, see Table 3, Table 4). Estimated population size declined significantly within the last year from an estimated 8547 animal in Mar-Apr 2013 to 2557 animals in Mar-Apr 2014 (Figure 4). This decline is also reflected in low numbers estimated in the Oct-Nov 2013 survey. Excluding Palmwag shows a similar pattern of decline. Annual Northwest Game Count population estimates for 2011-2013 estimates are shown for comparison (Figure 4); these estimates do not clearly reflect the declining pattern our seasonal surveys indicate but the 2014 estimate will be important as this will most closely fall within the time period of our surveys that show the most pronounced trend.

The regional decline is reflected in Conservancy and the Concession areas population estimates we have calculated (Table 5, Figure 5, Figure 6) with estimated numbers reaching their lowest in Mar-Apr 2014 for all areas and some numbers being orders of magnitude lower than earlier survey estimates. Conservancy-level estimates represent a mix of distance-based estimates and strip transect-based analyses (see Appendix II for details). Further monitoring is needed to see if the downward trend continues or if the recent reprieve from drought conditions will result in the population stabilizing and recovering.

Table 3. Gemsbok population density and size estimates for 5 Conservancies for surveys completed between October 2011 and April 2014

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	888	951	666	436	398	326
Density	0.0083	0.0106	0.0093	0.0041	0.0051	0.0017
95% Conf. Interval	0.0051 - 0.0136	0.0059 - 0.0190	0.0057 - 0.0152	0.0024 - 0.0071	0.0030-0.0087	0.0009-0.0031
Abundance	6070	7719	6787	2991	3746	1209
95% Conf. Interval	3702 - 13789	4294 - 14506	4133 - 11143	1718 - 5205	2197-6387	642-2275

Table 4. Gemsbok population density and size estimates including Palmwag Concession and the 5 Conservancies based on surveys completed between October 2011 and April 2014

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	1044	790	643	574
Density	0.0097	0.0081	0.0058	0.0024
95% Conf. Interval	0.0067 - 0.0140	0.0051 - 0.0128	0.0038-0.0089	0.0015-0.0039
Abundance	10257	8547	6166	2557
95% Conf. Interval	7066 - 14888	5379 - 13582	4051-9386	1585-4127

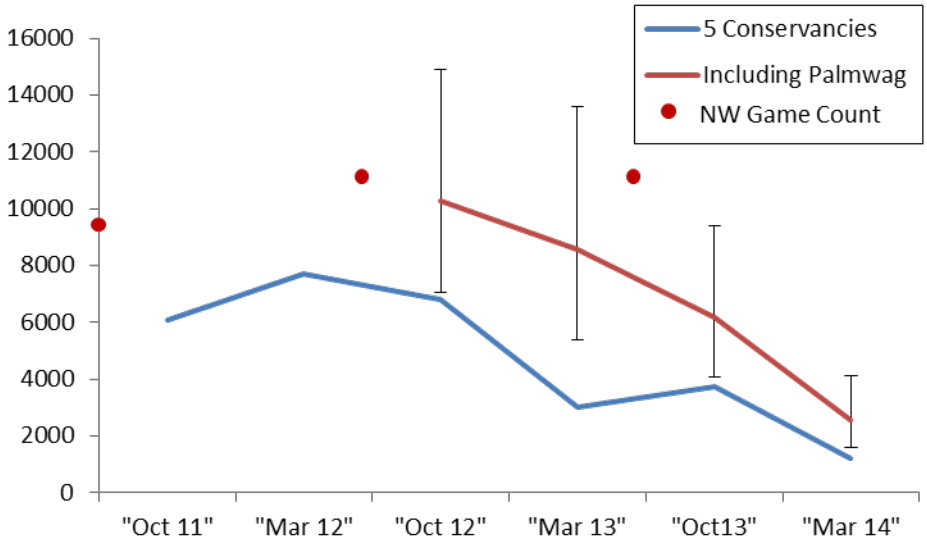

Figure 4. Estimated population size of Gemsbok based on 6 seasonal surveys across 5 Conservancies in the Kunene region of northern Namibia; population estimates including the Palmwag Concession in the latter 4 surveys are shown with 95% confidence intervals and the Northwest Game Count population estimate for our survey area including Palmwag Concession is shown.

Table 5. Average annual population size of Gemsbok in each of 5 Conservancies and the Palmwag Concession based on the average of 2 seasonal estimates each year in 2012 and 2013 and single surveys in 2011 and 2014 (and 2012 for Palmwag Concession); the overall average is the average of all seasonal surveys completed to date.

	2011[1]	2012	2013	2014[1]	Average
Anabeb	333	166	181	20	**175**
Ehirovipuka	356	886	337	24	**401**
Omatendeka	1217	1163	243	41	**666**
Palmwag		4502[1]	4301	1218	**3340**
Sesfontein	1268	1456	1238	312	**1068**
Torra	3181	3863	2286	697	**2507**

[1]Only a single survey was completed for these estimates; all other data in table represent the average of 2 surveys.

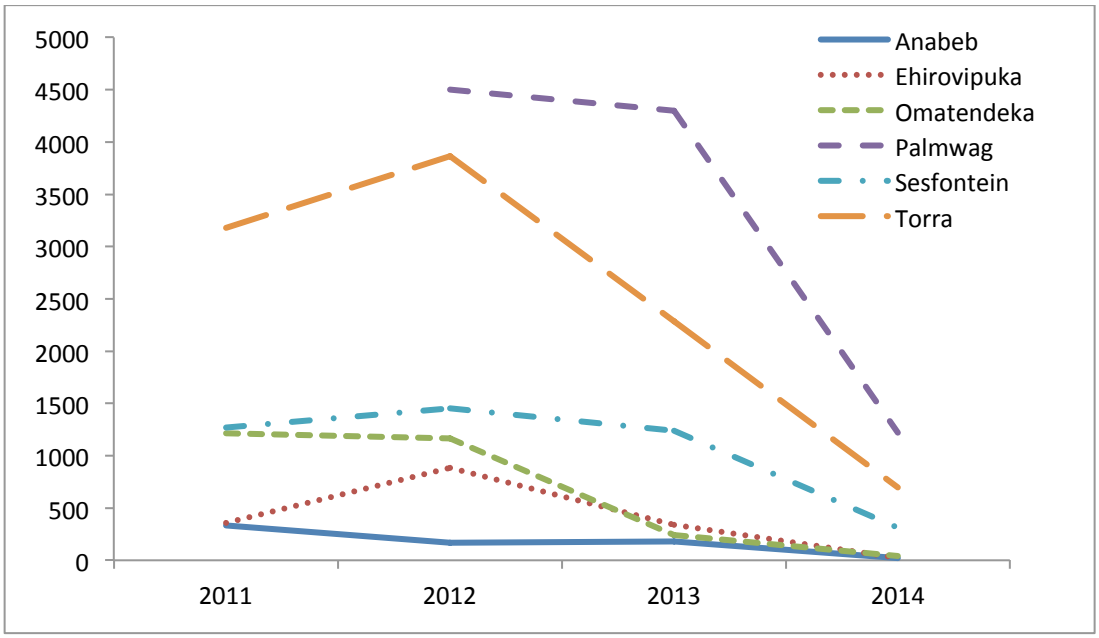

Figure 5. Gemsbok estimated annual populations within each of 5 Conservancies and the Palmwag Concession based on surveys completed between October 2011 and April 2014; 2011 and 2014 values represent a single survey while 2012 and 2013 represent the average of 2 surveys completed in those years.

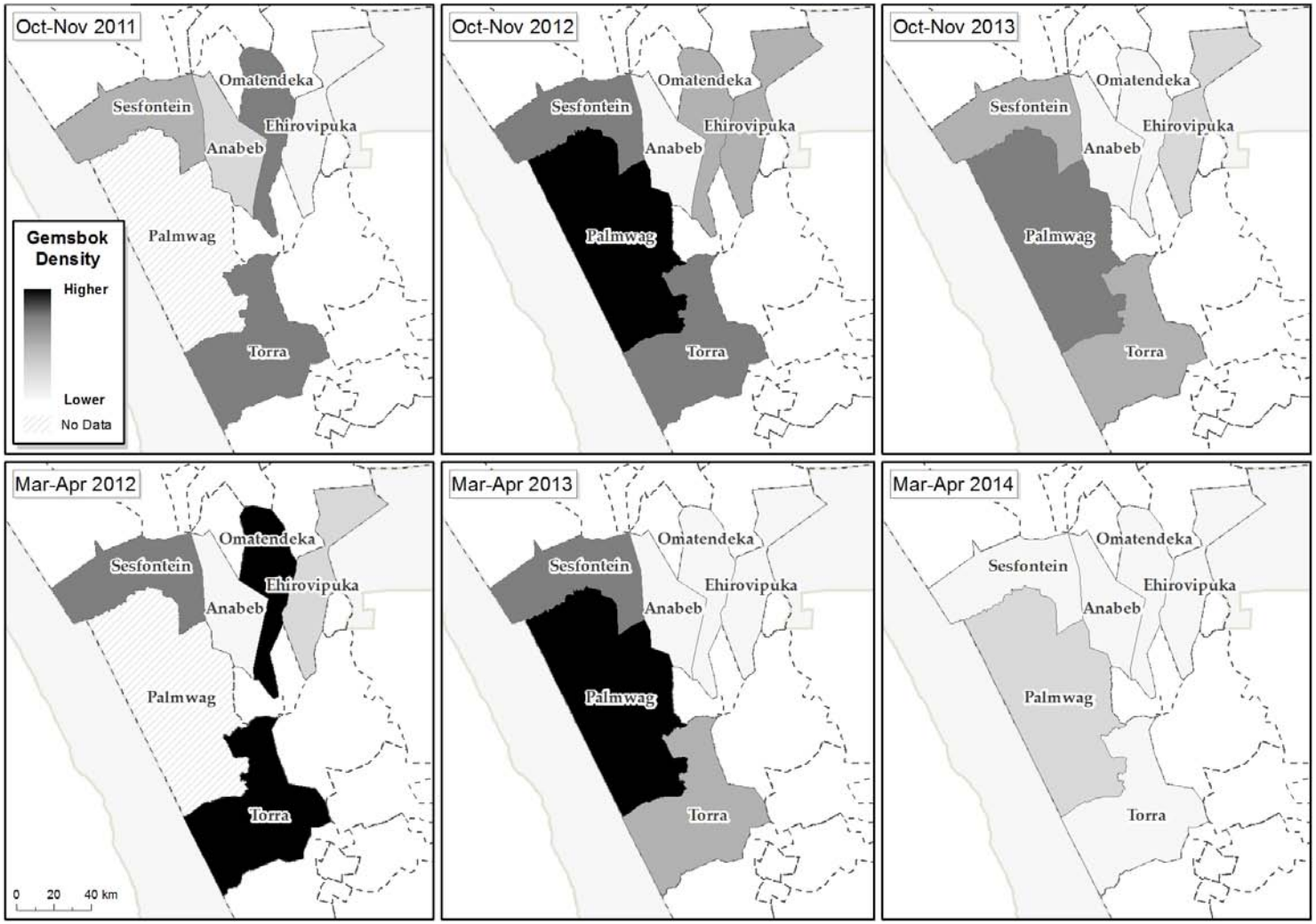

Figure 6. Maps showing the population density of Gemsbok estimated from individual surveys completed between October 2011 and April 2014 for each Conservancy and the Palmwag Concession based on distance analyses and strip transect analyses; Palmwag Concession was included in surveys starting in October 2012.

HARTMANN'S MOUNTAIN ZEBRA

Examination of the data distributions and statistics indicated the best fit model was supported by subsampling the data within each season to those animals within 1200m of the transect routes. Total numbers of individuals included in the analyses ranged from 590 to 1761 across the 5 Conservancies and Palmwag Concession. Zebra data for Mar-Apr 2014 were grouped into distance categories to improve the fit of the model; additional information on the analyses is summarized in Appendix II.

Regional densities of zebra were lower in Oct-Nov 2013 than in Mar-Apr 2014 (Table 6, Table 7). Differences between seasonal predicted animal population sizes are not statistically different, but suggest a seasonal pattern in highs and lows (Figure 7). This pattern was first noted in Heinemeyer et al 2013 where it was suggested that it could be due to seasonal differences in distribution relative to transects or sightability differences between seasons. It is interesting that the North-West Game Count, conducted in June annually, also shows relatively high variation between surveys which suggests the pattern may not be seasonal but potentially actual population fluctuations (Figure 7).

We have relied upon both distance-based modeling and strip transect analyses to estimate Conservancy and Concession population numbers, depending upon sample size and analyses assumptions that would provide the most robust analyses as these smaller sample sizes; the estimate for each seasonal survey and the method used to derive it are provided in Appendix II. The low estimated in our Oct-Nov 2013 regional modeling is reflected in all the Conservancies and in the Concession during that season (Figure 9) but the Conservancy/Concession annual averages smooth this seasonal pattern (Table 8, Figure 8). It is notable that we only counted 17 individuals in the Ehirovipuka Conservancy in the Mar-Apr 2014 survey leading to a predicted reduction in numbers there for Mar-Apr 2014 unlike most areas that saw possible rebounding numbers. Given the wide variation in numbers season to season and year-to-year, it is challenging to interpret any potential patterns in the Zebra population, including any response to the drought or recent rainfall.

Table 6. Summary of data and distance sampling analyses of Hartmann's Mountain Zebra across 6 seasonal surveys completed 5 communal Conservancies, excluding Palmwag Concession, in the Kunene region of northern Namibia.

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	1189	1621	647	946	388	1181
Density	0.00731	0.0131	0.0066	0.0134	0.0046	0.0091
95% Conf. Interval	0.0041 - 0.0129	0.0070 - 0.0243	0.0034 - 0.0128	0.0074 - 0.0242	0.0022-0.0096	0.0051-0.0161
Abundance	5341	9538	4798	9808	3392	6674
95% Conf. Interval	3022 – 9440	5111 – 17801	2452 – 9387	5432 - 17709	1636-7036	3758-11851

Table 7. Summary of data and distance sampling analyses of Hartmann's Mountain Zebra across 6 seasonal surveys completed in 5 communal Conservancies and Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	1545	1597	590	1761
Density	0.0117	0.0116	0.0046	0.0109
95% Conf. Interval	0.0068 - 0.0200	0.0077 - 0.0176	0.0026-0.0083	0.0067-0.0178
Abundance	12387	12332	4896	11575
95% Conf. Interval	7225 - 21237	8127 - 18712	2726-8794	7103-18861

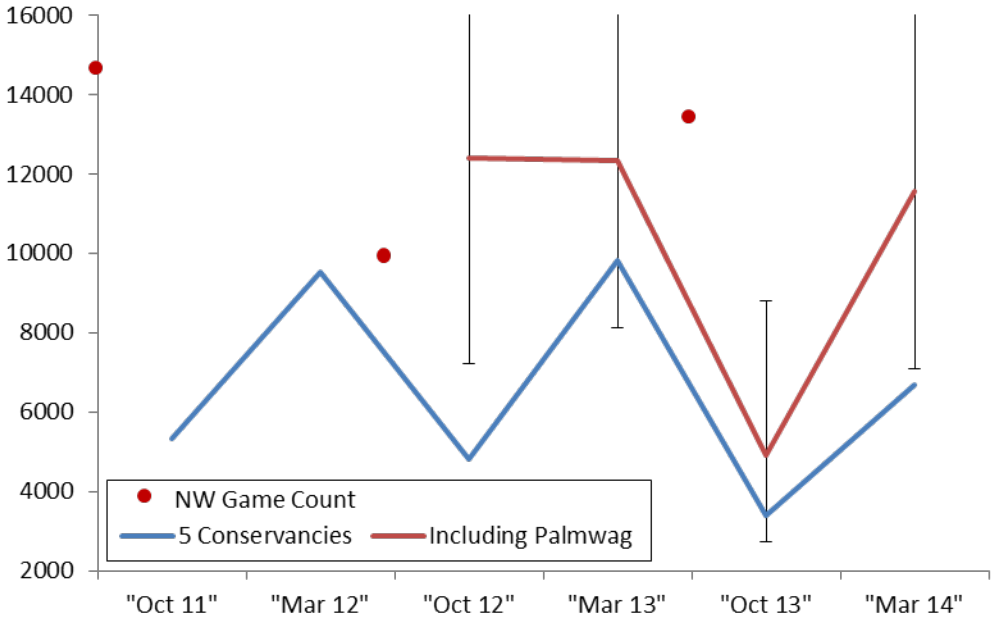

Figure 7. Estimated population size of Hartmann's Mountain Zebra based on 6 seasonal surveys across 5 Conservancies in the Kunene region of northern Namibia; population estimates including the Palmwag Concession in the last 4 surveys are shown with 95% confidence intervals and the Northwest Game Count population estimate for our survey area including Palmwag Concession is shown.

Table 8. Average annual population size of Hartmann's Mountain Zebra in each of 5 Conservancies and the Palmwag Concession based on the average of 2 seasonal estimates each year in 2012 and 2013 and single surveys in 2011 and 2014 (and 2012 for Palmwag Concession); the overall average is the average of all seasonal surveys completed to date.

	2011[1]	2012	2013	2014[1]	Average
Anabeb	860	1122	472	1590	**940**
Ehirovipuka	523	1087	2305	115	**1237**
Omatendeka	656	2096	221	950	**1040**
Palmwag		8336[1]	4207	4294	**5261**
Sesfontein	543	285	660	853	**548**
Torra	2909	3080	2719	3098	**2934**

[1]Only a single survey was completed for these estimates; all other data in table represent the average of 2 surveys.

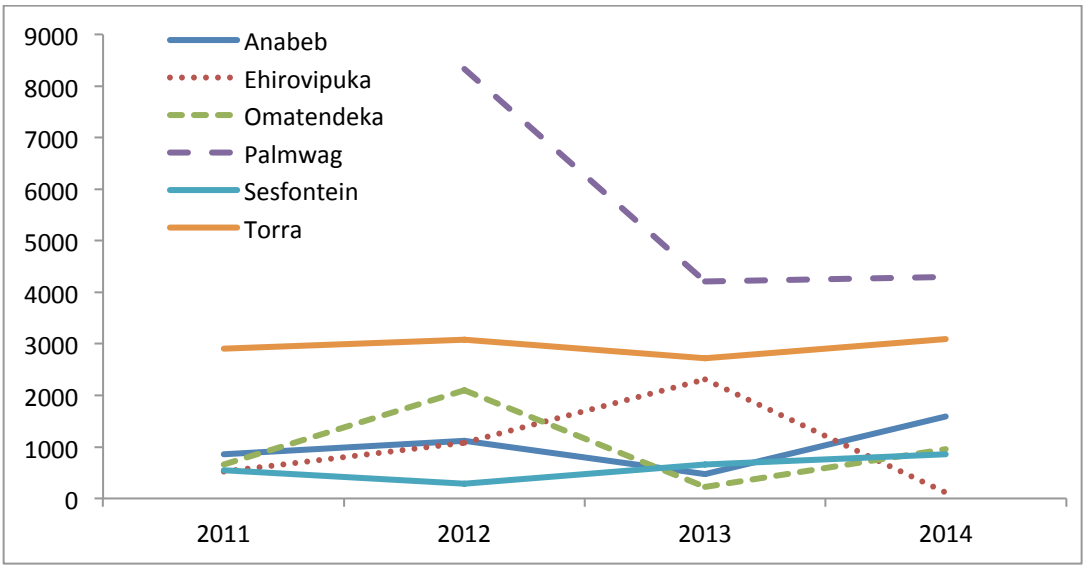

Figure 8. Zebra estimated annual populations within each of 5 Conservancies and the Palmwag Concession based on surveys completed between October 2011 and April 2014; 2011 and 2014 values represent a single survey while 2012 and 2013 represent the average of 2 surveys completed in those years.

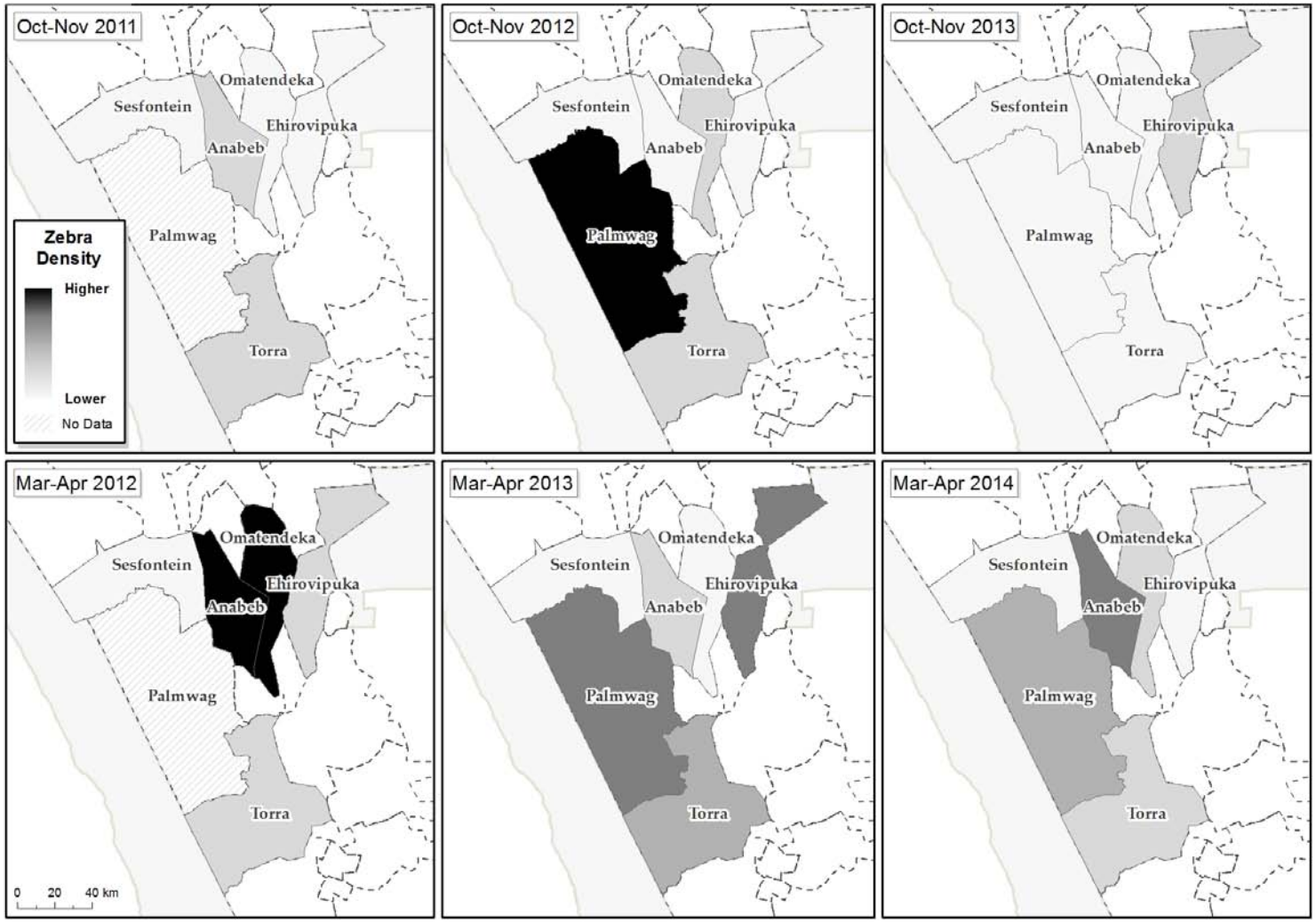

Figure 9. Maps showing the population density of Zebra estimated from individual surveys completed between October 2011 and April 2014 for each Conservancy and the Palmwag Concession based on distance analyses and strip transect analyses; Palmwag Concession was included in surveys starting in October 2012.

SPRINGBOK

Within the 5 Conservancies, we included 1300 and 1903 Springbok in our regional population analyses for Oct-Nov 2013 and Mar-Apr 2014, respectively (Table 9). These counts increased to 1743 and 3481 when including the Palmwag Concession (Table 10). In Oct-Nov 2013, we also improved model fit by pooling the count data into distance classes.

Springbok density across the region was estimated at 0.0220 and 0.0322 animals/ha in Oct-Nov 2013 and Mar-Apr 2014, respectively (Table 10). For comparisons going back 3 years, we have also provided the estimated densities in just the 5 Conservancies (excluding Palmwag Concession; Table 9). When combined with prior seasonal estimates, Springbok appear to have a downward trend in population through Oct-Nov 2013 but may have increased numbers by Mar-Apr 2014 (Figure 10). These patterns are not statistically significant but could coincide with the drought conditions, which were relieved with rains in 2014. They also appear to coincide with the North-West Game Count estimates, at least for the 2011-2013 period; it will be interesting to compare the 2014 estimates (Figure 10).

Springbok were found in every Conservancy and in the Palmwag Concession during each seasonal survey. We present annual averages in Table 11 and Figure 11; individual survey estimates and the method used to derive it are provided in Appendix II. Population density estimates are commonly lower in Ehirovipuka and Omatendeka Conservancies compared to other areas, and Ehirovipuka estimates from the Mar-Apr 2014 survey suggest very low numbers. Alternatively, numbers of Springbok estimated in Sesfontein and Palmwag are quite high during the Mar-Apr 2014 period relative to prior years while other Conservancies appear to support fewer animals than in prior survey periods (Figure 12).

Table 9. Summary of data and distance sampling analyses of Springbok across 6 seasonal surveys completed in 5 communal Conservancies, excluding Palmwag Concession, in the Kunene region of northern Namibia.

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	1294	2404	1743	2039	1300	1903
Density	0.0164	0.0441	0.0353	0.0275	0.0233	0.0279
95% Conf. Interval	0.0105 - 0.0259	0.0243 - 0.0800	0.0245 - 0.0508	0.0168 - 0.0451	0.0145 – 0.0374	0.0118-0.0659
Abundance	12001	32245	25781	20128	17020	20380
95% Conf. Interval	7643 - 18843	17775 - 58493	17909 - 37113	12288 - 32973	10612 - 27299	8627 - 48145

Table 10. Summary of data and distance sampling analyses of Springbok across 4 seasonal surveys completed in 5 communal Conservancies and Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	2615	2810	1743	3481
Density	0.0365	0.0286	0.022	0.0322
95% Conf. Interval	0.0271 - 0.0492	0.0193 - 0.0422	0.01455-0.0335	0.0173-0.0600
Abundance	38683	30269	23413	34154
95% Conf. Interval	28709 - 52122	20482 - 44733	15426-35533	18320 -63674

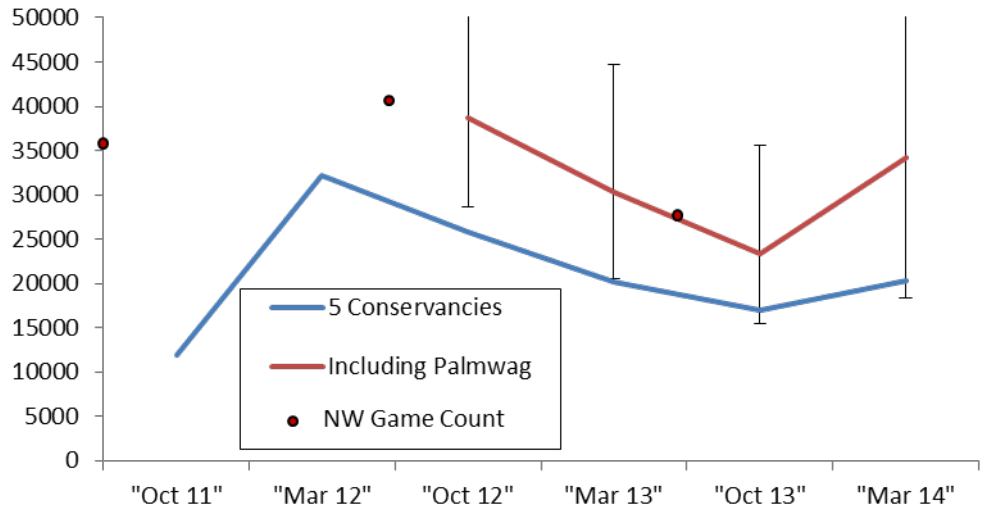

Figure 10. Estimated population size of Springbok based on 6 seasonal surveys across 5 Conservancies in the Kunene region of northern Namibia; population estimates including the Palmwag Concession in the latter 4 surveys are shown with 95% confidence intervals and the Northwest Game Count population estimate for our survey area including Palmwag Concession is shown.

Table 11. Average annual population size of Springbok in each of 5 Conservancies and the Palmwag Concession based on 2 seasonal estimates each year in 2012 and 2013 and single surveys in 2011 and 2014 (and 2012 for Palmwag Concession); the overall average is the average of all seasonal surveys completed to date.

	2011[1]	2012	2013	2014[1]	Average
Anabeb	1308	6026	3137	2180	**3636**
Ehirovipuka	51	2619	3230	12	**1960**
Omatendeka	1129	4082	1898	1126	**2369**
Palmwag		13984[1]	10571	18712	**13460**
Sesfontein	2548	3242	1865	8050	**3469**
Torra	6564	10183	6773	3822	**7383**

[1]Only a single survey was completed for these estimates; all other data in table represent the average of 2 surveys.

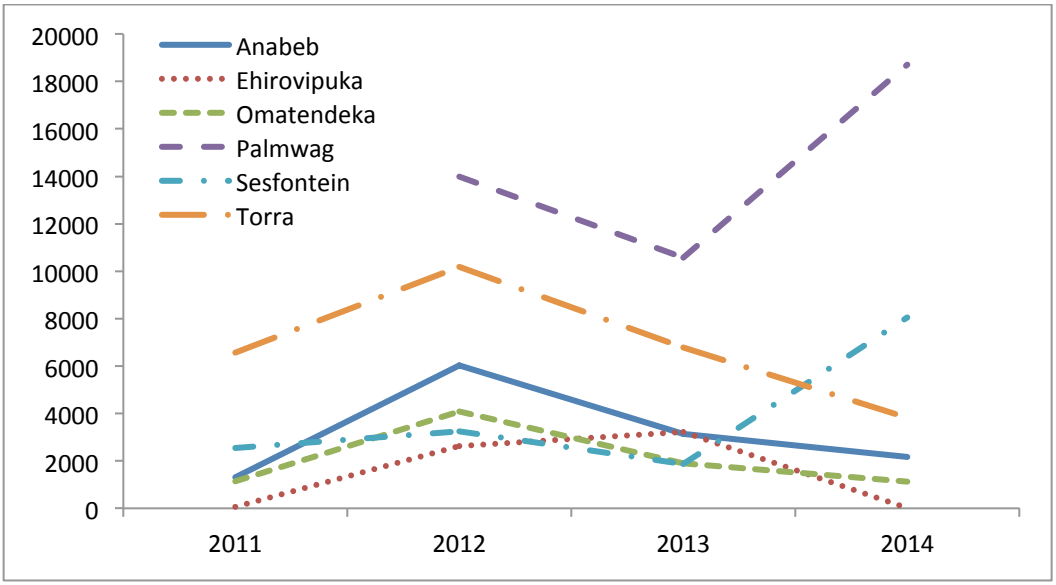

Figure 11. Springbok estimated annual populations within each of 5 Conservancies and the Palmwag Concession based on surveys completed between October 2011 and April 2014; 2011 and 2014 values represent a single survey while 2012 and 2013 represent the average of 2 surveys completed in those years.

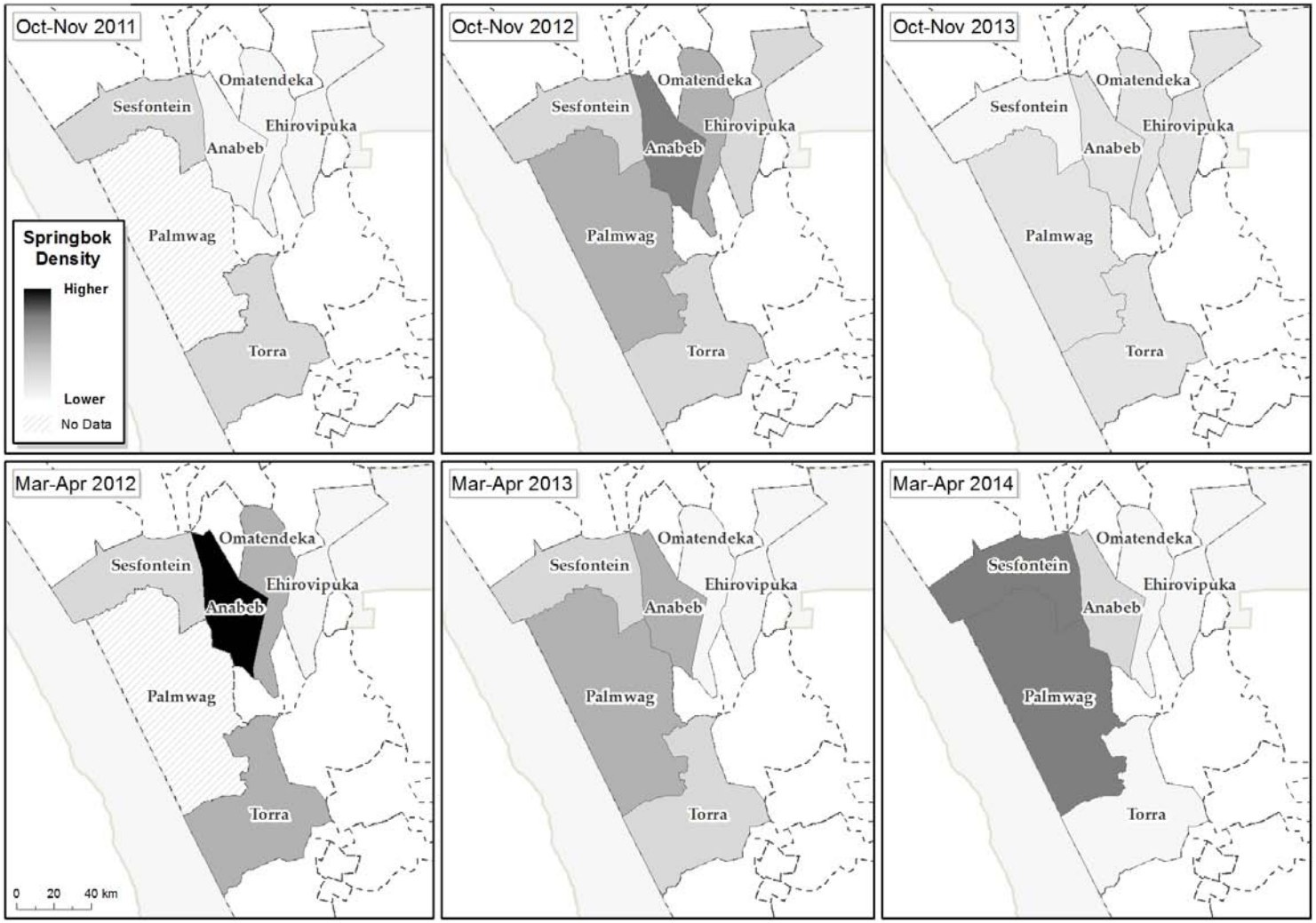

Figure 12. Maps showing the population density of Springbok estimated from individual surveys completed between October 2011 and April 2014 for each Conservancy and the Palmwag Concession based on distance analyses and strip transect analyses; Palmwag Concession was included in surveys starting in October 2012.

KUDU

Kudu counts were low in both the Oct-Nov 2013 (25 groups for a total of 93 individuals) and Mar-Apr 2014 (8 groups for a total of 35 individuals). We were able to develop marginally acceptable models for the Oct-Nov 2013 data to provide a distance-based population estimates for the 5 Conservancies (Table 12) and also for the 5 Conservancies and Palmwag Concession (Table 13). These models are of marginal acceptability given the low sample sizes. We also analyzed the data using strip transect analyses based on the global ESW; these estimates are similar and we present the distance-based model results which provide additional measures of model fit and confidence around estimates. The number of Kudu counted was insufficient to allow distance-based analyses of Mar-Apr 2014 survey data. We used Distance 6.0 to assess the distribution of the data and provide an ESW estimate, which we used in strip transect analyses to provide estimates of population sizes at the region with and without the inclusion of Palmwag Concession (Table 12, 13). Additional analyses details are in Appendix II. The intent of the analyses is to provide information and insights that may assist managing a relatively rare species but we urge additional caution in interpreting these estimates.

Kudu density across the region was estimated at 0.0013 animals/ha in Oct-Nov 2013 and 0.00036 in Mar-Apr 2014. While not statistically significant, the information collected in Mar-Apr 2014 suggests that Kudu may have declined in the region (Figure 13). The North West Game Count estimates for prior periods are similar to our population estimates (Figure 13) and the NWGC June 2014 should provide additional insights into the current status of the low-density species.

Conservancy and Concession-level population estimates were derived using strip transect methods (Appendix II). In Oct-Nov 2013 Kudu were found in 4 of the 5 Conservancies and in the Palmwag Concession. In Mar-Apr 2014, Kudu were not observed in Omatendeka Conservancy, Palmwag Concession or Sesfontein Concession. While we have not observed Kudu in Sesfontein during any of our surveys over the last 3 years, Kudu have been found in the other 2 areas in the past and Palmwag has represented some of our higher counts of the species in the past (Table 14). Palmwag and Torra show notable declines in Kudu population estimates through time (Figure 14, Figure 15). This species may be under stress across the region related to the recent drought conditions.

Table 12. Summary of data and distance sampling analyses of Kudu across 6 seasonal surveys completed in 5 communal Conservancies, excluding Palmwag Concession, in the Kunene region of northern Namibia.

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	133	54	112	42	54	35
Density	0.0019	0.0008	0.0031	0.0005	0.0004	0.00046*
95% Conf. Interval	0.0008 - 0.0046	0.0003 - 0.0020	0.0011 - 0.0089	0.0003 - 0.0012	0.0002-0.0012	-
Abundance	1361	582	1335	402	347	338*
95% Conf. Interval	552 - 3355	228 - 1484	862 - 9083	184 - 875	135-889	-

*Population estimates based on strip transects

Table 13. Summary of data and distance sampling analyses of Kudu across 6 seasonal surveys completed in 5 communal Conservancies including Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	144	34	93	35
Regional Density	0.0031	0.0006	0.0013	0.00036*
95% Conf. Interval	0.0013 - 0.0100	0.0003 - 0.0015	0.0005-0.0040	-
Abundance	3860	676	1425	374*
95% Conf. Interval	1411 - 10562	287 - 1588	484-4197	-

*Population estimates based on strip transects

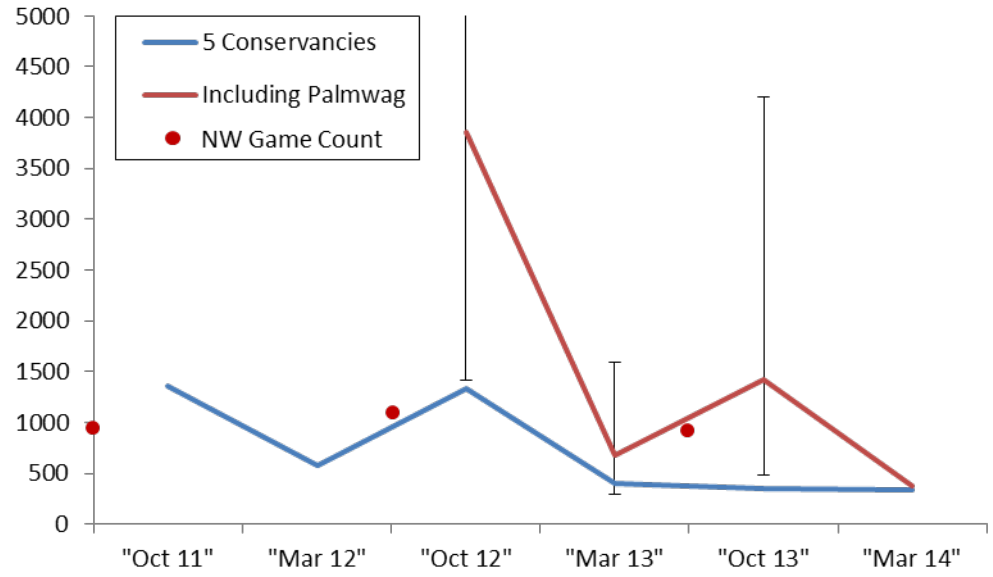

Figure 13. Estimated population size of Kudu based on 6 seasonal surveys across 5 Conservancies in the Kunene region of northern Namibia; population estimates including the Palmwag Concession in the latter 4 surveys are shown with 95% confidence intervals if available and the Northwest Game Count population estimate for our survey area including Palmwag Concession is shown.

Table 14. Average annual population size of Kudu in each of 5 Conservancies and the Palmwag Concession based on 2 seasonal estimates each year in 2012 and 2013 and single surveys in 2011 and 2014 (and 2012 for Palmwag Concession); the overall average is the average of all seasonal surveys completed to date.

	2011[1]	**2012**	**2013**	**2014**[1]	**Average**
Anabeb	161	161	37	69	**104**
Ehirovipuka	57	329	68	89	**157**
Omatendeka	43	388	70	0	**160**
Palmwag		1080[1]	565	0	**553**
Sesfontein	0	0	52	0	**17**
Torra	1254	895	380	221	**671**

[1]Only a single survey was completed for these estimates; all other data in table represent the average of 2 surveys.

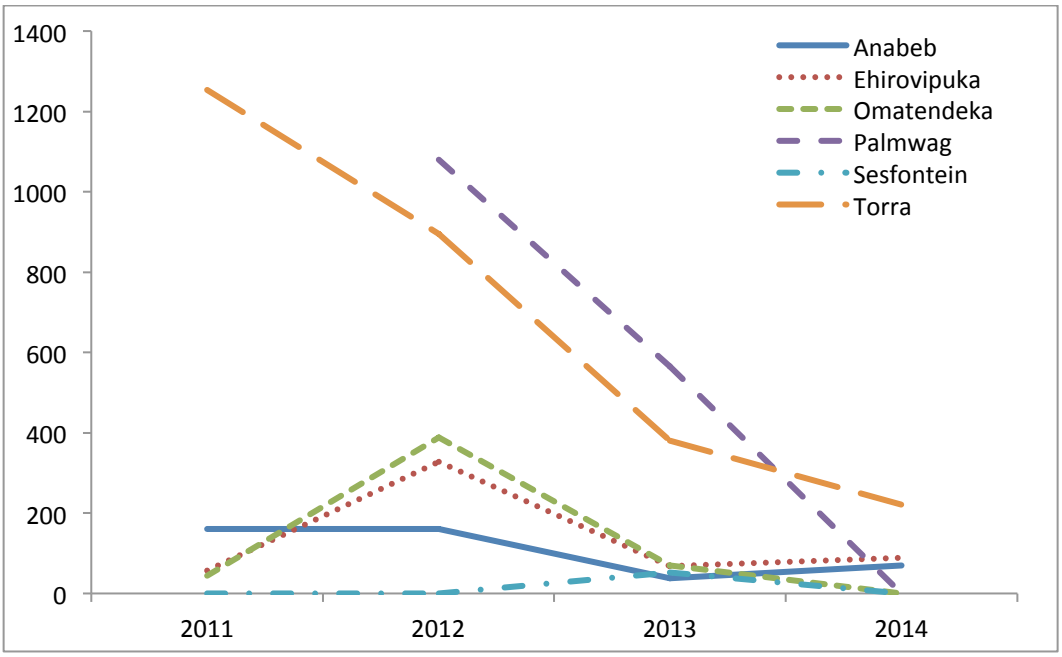

Figure 14. Kudu estimated annual populations within each of 5 Conservancies and the Palmwag Concession based on surveys completed between October 2011 and April 2014; 2011 and 2014 values represent a single survey while 2012 and 2013 represent the average of 2 surveys completed in those years.

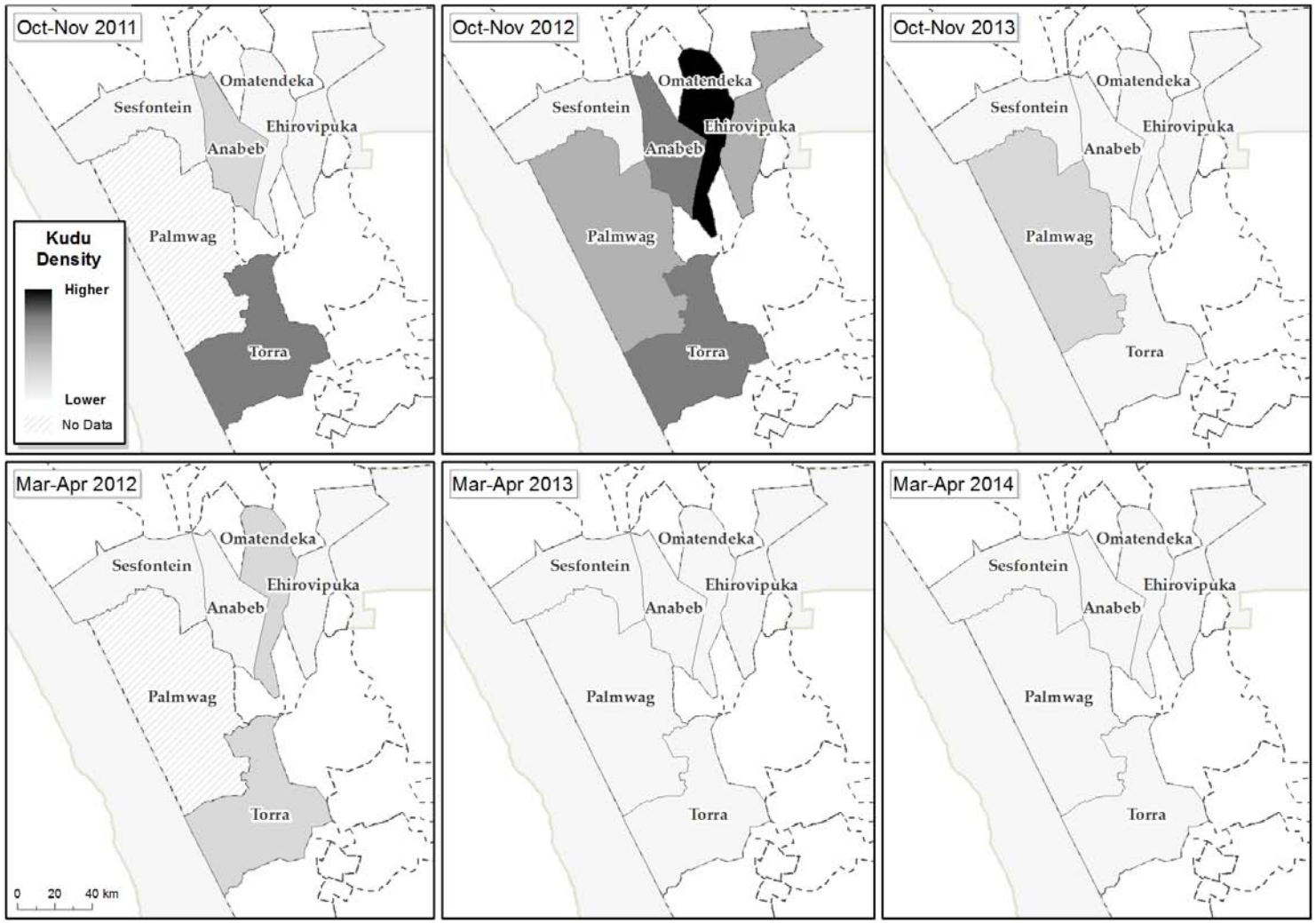

Figure 15. Maps showing the population density of Kudu estimated from individual surveys completed between October 2011 and April 2014 for each Conservancy and the Palmwag Concession based on distance analyses and strip transect analyses; Palmwag Concession was included in surveys starting in October 2012.

GIRAFFE

Table 15. Modeling parameters and summary results for regional Giraffe observations within 1000m of transect routes were used in population estimation. Across the 5 Conservancies, 64 groups representing 173 individuals and 36 groups representing 147 individuals were included from Oct-Nov 2013 and Mar-Apr 2014 surveys, respectively (Table 16). The Palmwag Concession increased the animals seen, with 85 groups (231 individuals) and 42 groups (183 individuals) in Oct-Nov 2013 and Mar-Apr 2014 respectively (Table 16).

A notable level of consistency marks population estimates for regional Giraffe populations across seasonal surveys prior to the Mar-Apr 2014 survey (Figure 16). In Mar-Apr 2014, estimates for regional populations suggest a decline. Giraffe density for the region in Oct-Nov 2013 was estimated at 0.0017, dropping to 0.0008 in Mar-Apr 2014. This is not a statistically significant change, but further monitoring is needed to see if the possible decline continues or is an artifact of the survey season. Additional modeling details are provided in Appendix II.

We have relied upon both distance-based modeling and strip transect analyses to estimate Conservancy and Concession Giraffe population numbers, depending upon sample size and analyses assumptions that would provide the most robust analyses as these smaller sample sizes; the estimate for each seasonal survey and the method used to derive it are provided in Appendix II. Giraffe were found in all 5 Conservancies and in the Palmwag Concession during each seasonal survey (Table 17, Figure 17) but are consistently in higher estimated densities in the Ehirovipuka and Omatendeka (Figure 18). Average population density and size estimates were lowest in the Anabeb Conservancies and highest in the Ehirovipuka Conservancy. The potential decline noted at the regional level is evidenced in the area-specific analyses, with low numbers or declining trends apparent in most of the western areas and possibly also in Omatendeka over the last couple surveys (Figure 17, Figure 18). Giraffe may have been negatively affected by the drought conditions, and additional population monitoring is warranted.

Table 16. Modeling parameters and summary results for regional Giraffe population estimates across 6 seasonal surveys in 5 communal Conservancies, excluding Palmwag Concession, in the Kunene region of northern Namibia

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	129	192	147	206	173	147
Density	0.0018	0.0017	0.0018	0.0017	0.0019	0.0006
95% Conf. Interval	0.0008 - 0.0042	0.0006 - 0.0047	0.0009 - 0.0034	0.0009 - 0.0034	0.0009-0.0039	0.0003-0.0014
Abundance	1296	1233	1284	1272	1385	467
95% Conf. Interval	553 - 3042	444 - 3421	667 - 2472	645 - 2507	682-2814	207-1052

Giraffe population estimates across 6 seasonal surveys and Palmwag Concession in the Kunene region of northern Namibia

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	214	234	231	183
Regional Density	0.0021	0.0015	0.0017	0.0008
95% Conf. Interval	0.0012 - 0.0039	0.0008 - 0.0027	0.0009-0.0030	0.0004-0.0016
Abundance	2260	1605	1762	810
95% Conf. Interval	1227 - 4165	889 - 2897	975-3184	394-1664

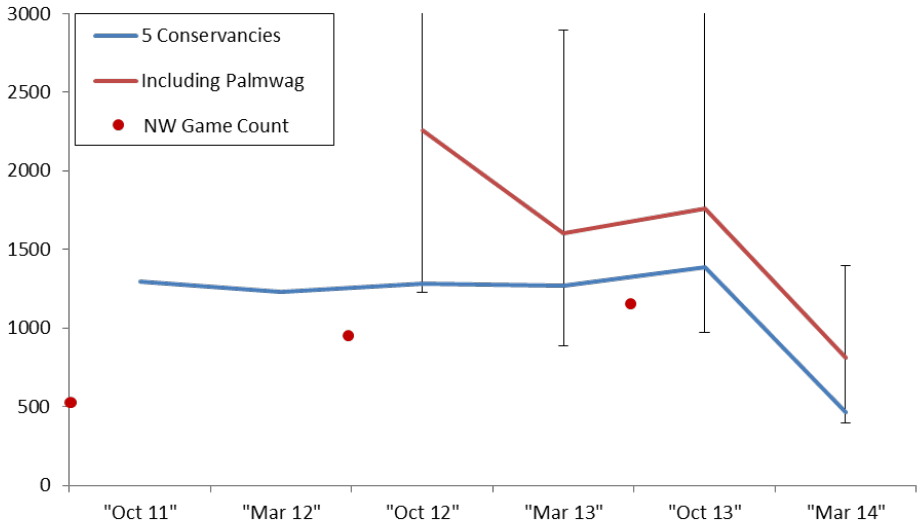

Figure 16. Estimated population size of Giraffe based on 6 seasonal surveys across 5 Conservancies in the Kunene region of northern Namibia; population estimates including the Palmwag Concession in the latter 4 surveys are shown with 95% confidence intervals and the Northwest Game Count population estimate for our survey area including Palmwag Concession is shown.

Table 17. Average annual population size of Giraffe in each of 5 Conservancies and the Palmwag Concession based on 2 seasonal estimates each year in 2012 and 2013 and single surveys in 2011 and 2014 (and 2012 for Palmwag Concession); the overall average is the average of all seasonal surveys completed to date.

	2011[1]	2012	2013	2014[1]	Average
Anabeb	58	45	104	11	**61**
Ehirovipuka	711	645	413	379	**534**
Omatendeka	134	414	287	133	**278**
Palmwag		694[1]	474	244	**471**
Sesfontein	77	99	92	57	**86**
Torra	429	221	263	125	**254**

[1]Only a single survey was completed for these estimates; all other data in table represent the average of 2 surveys.

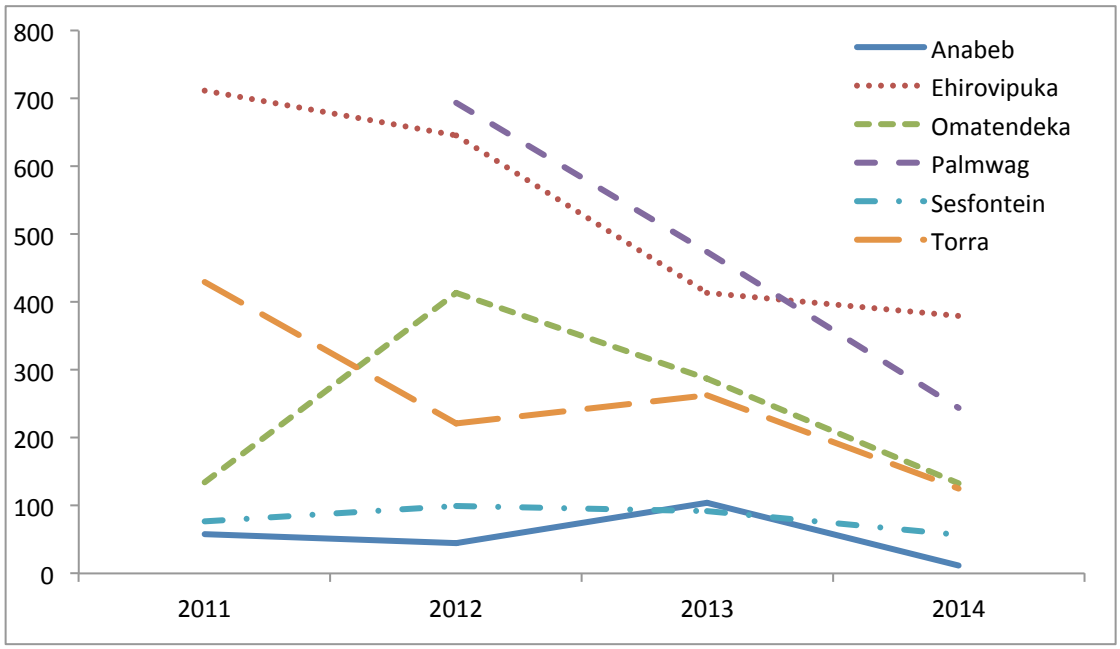

Figure 17. Giraffe estimated annual populations within each of 5 Conservancies and the Palmwag Concession based on surveys completed between October 2011 and April 2014; 2011 and 2014 values represent a single survey while 2012 and 2013 represent the average of 2 surveys completed in those years.

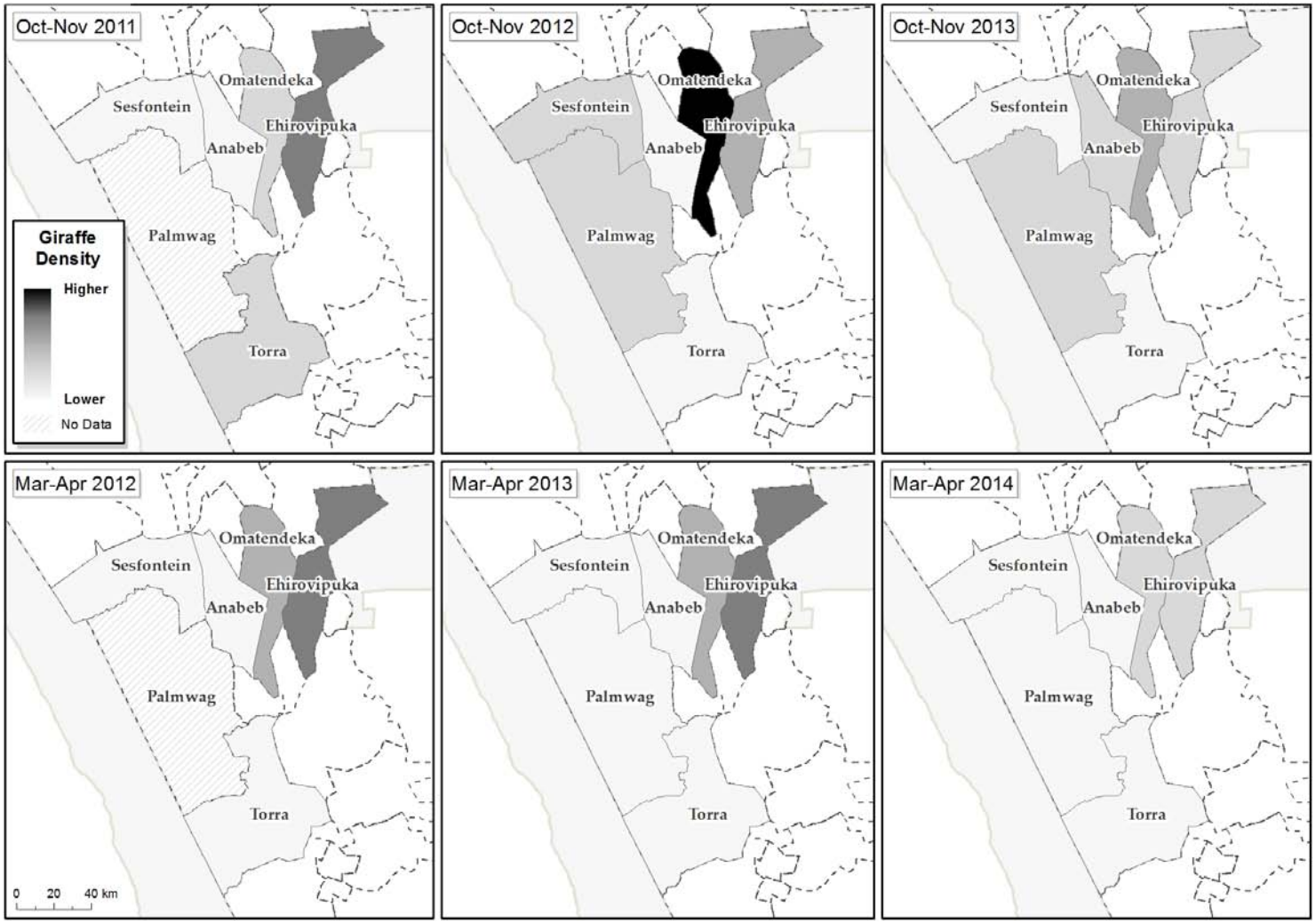

Figure 18. Maps showing the population density of Giraffe estimated from individual surveys completed between October 2011 and April 2014 for each Conservancy and the Palmwag Concession based on distance analyses and strip transect analyses; Palmwag Concession was included in surveys starting in October 2012.

OSTRICH

Examination of the data distributions and statistics indicated the best model was fit limiting observations within 1000m of the transect line. Across the 5 Conservancies, 35 groups representing 119 individuals and 49 groups representing 113 individuals were included in the analyses for Oct-Nov 2013 and Mar-Apr 2014 surveys, respectively (Table 18). The Palmwag Concession increased the birds seen, to 47 groups (172 individuals) and 61 groups (150 individuals) in Oct-Nov 2013 and Mar-Apr 2014 respectively (Table 19). Estimates of Ostrich populations potentially indicate a regional decline with estimated population sizes and densities declining since a peak in Mar-Apr 2012 (Table 18, Table 19, Figure 19). The trend is not statistically significant and is not apparent with the inclusion of the Palmwag Concession in the population estimates since Oct-Nov 2012 (Figure 19). Also, the North-West Game Count data does not seem to indicate a decline but actually potentially an increase (Figure 19). Confidence intervals are broad around the estimates, reflecting the low sample size indicative of monitoring a low density species. Additional modeling information is available in Appendix II.

Ostrich were found in all 5 Conservancies and in the Palmwag Concession during each seasonal survey (Table 20, Figure 20, Figure 21). We have relied upon both distance-based modeling and strip transect analyses to estimate Conservancy and Concession Ostrich population numbers, depending upon sample size and analyses assumptions that provide the most robust analyses with these smaller sample sizes; the estimate for each seasonal survey and the method used to derive it are provided in Appendix II. Population density estimates tended to be lower in the more eastern Conservancies and higher in more western areas for most seasonal surveys. The potential declines noted above for the regional estimates are more striking looking at some of these areas, including Torra Conservancy and Palmwag Concession (Figure 20, Figure 21). Still, confidence in any survey result is low, and additional monitoring is warranted to further document population patterns.

Table 18. Summary of data and distance sampling analyses of Ostrich across 6 seasonal surveys completed in 5 communal Conservancies and Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	113	264	159	173	119	113
Density	0.0007	0.0034	0.002	0.0015	0.0008	0.0010
95% Conf. Interval	0.0004 - 0.0013	0.0018 - 0.0066	0.0011 - 0.0037	0.0008 - 0.0027	0.0004-0.0016	0.0005-0.0019
Abundance	506	2512	1451	1066	533	709
95% Conf. Interval	274 - 937	1300 - 4851	788 - 2673	579 – 1963	266-1129	368-1364

Table 19. Summary of data and distance sampling analyses of Ostrich across 6 seasonal surveys completed in 5 communal Conservancies and Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Total Count	210	254	172	150
Density	0.0015	0.0015	0.0009	0.0011
95% Conf. Interval	0.00097 - 0.0024	0.0009 - 0.0023	0.0005-0.0016	0.0006-0.0018
Abundance	1638	1578	994	1125
95% Conf. Interval	1032 - 2600	1001 - 2489	573-1723	655-1932

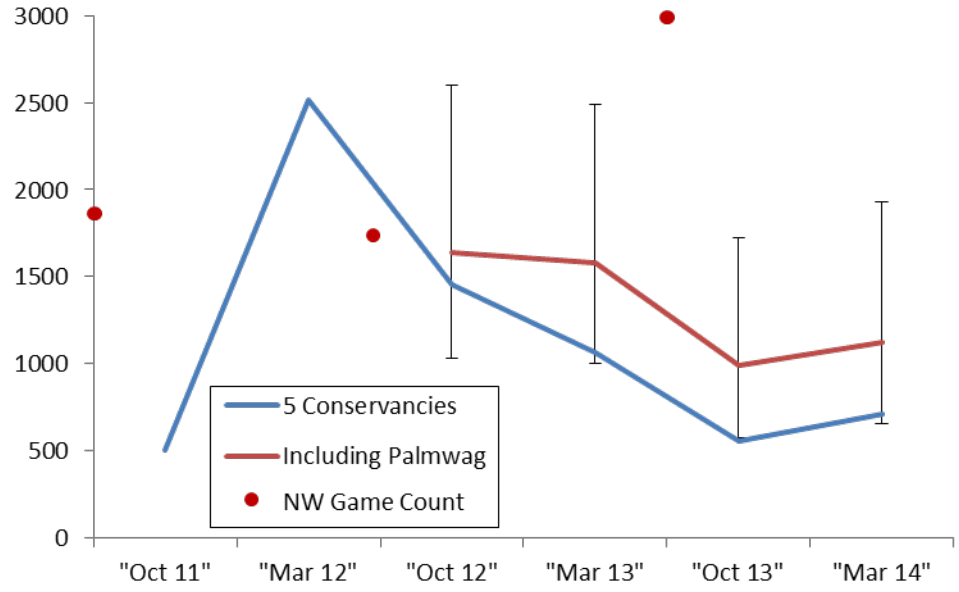

Figure 19. Estimated population size of Ostrich based on 6 seasonal surveys across 5 Conservancies in the Kunene region of northern Namibia; population estimates including the Palmwag Concession in the latter 4 surveys are shown with 95% confidence intervals.

Table 20. Average annual population size of Ostrich in each of 5 Conservancies and the Palmwag Concession based on 2 seasonal estimates each year in 2012 and 2013 and single surveys in 2011 and 2014 (and 2012 for Palmwag Concession); the overall average is the average of all seasonal surveys completed to date.

	2011[1]	2012	2013	2014[1]	Average
Anabeb	33	129	45	76	**76**
Ehirovipuka	41	98	56	87	**73**
Omatendeka	11	259	60	45	**116**
Palmwag	0	630[1]	582	289	**521**
Sesfontein	270	358	94	361	**256**
Torra	162	769	665	212	**540**

[1]Only a single survey was completed for these estimates; all other data in table represent the average of 2 surveys.

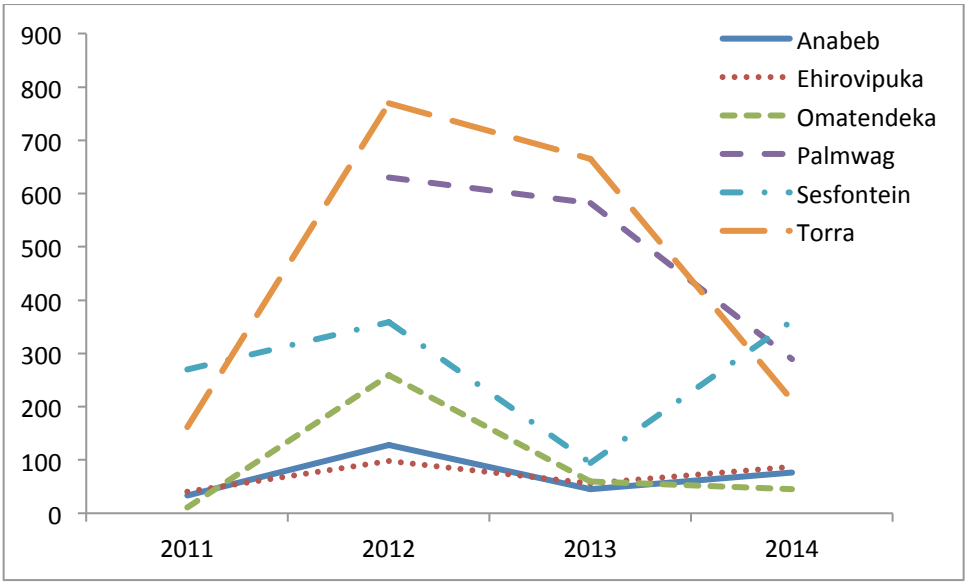

Figure 20. Ostrich estimated annual populations within each of 5 Conservancies and the Palmwag Concession based on surveys completed between October 2011 and April 2014; 2011 and 2014 values represent a single survey while 2012 and 2013 represent the average of 2 surveys completed in those years.

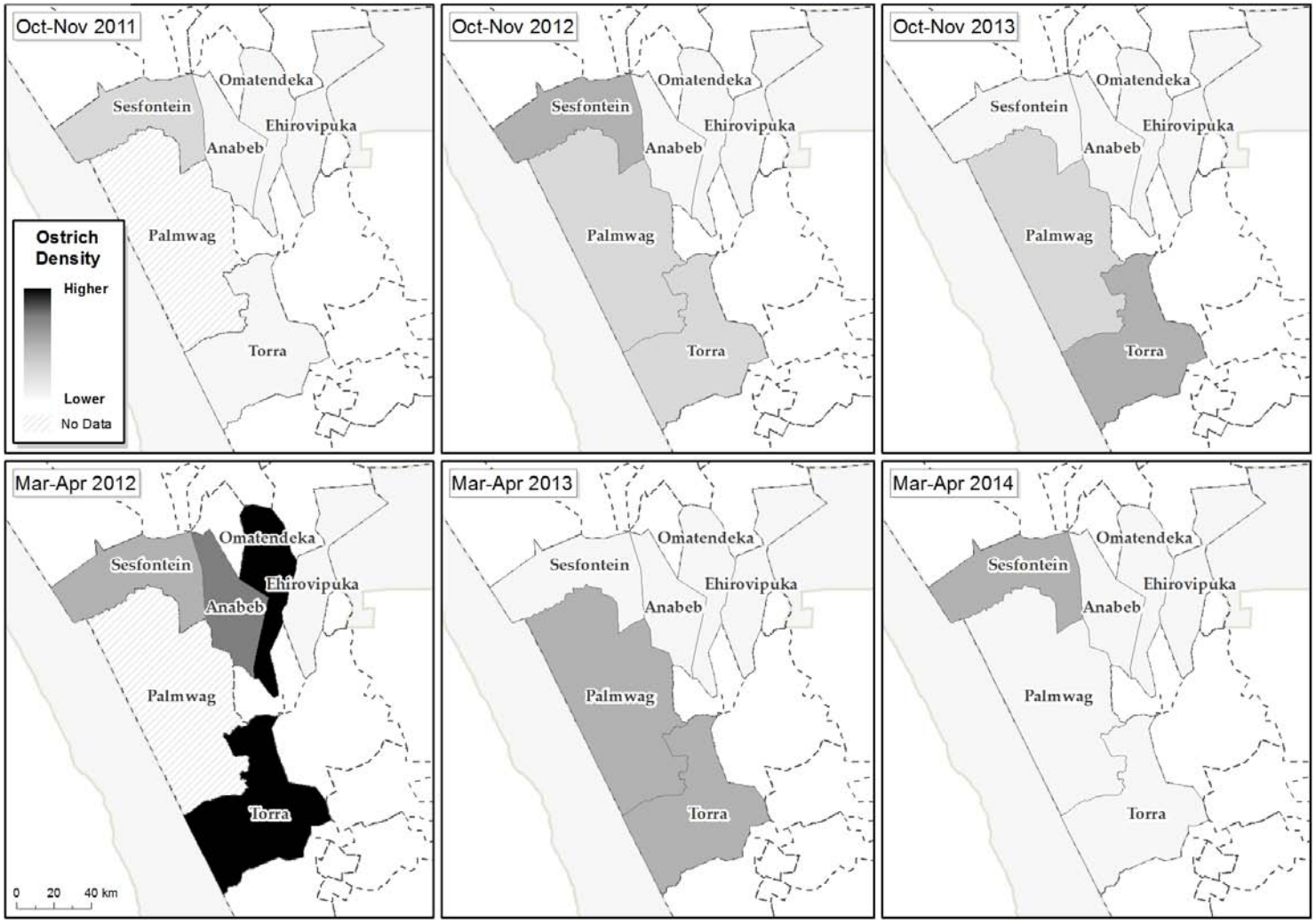

Figure 21. Maps showing the average population density and population size of Ostrich estimated by on 6 seasonal estimates calculated from game count surveys completed between Oct 2011 and Apr 2014.

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APPENDIX I: FIELD EFFORT AND DATA SUMMARY OF ROAD-BASED TRANSECT SURVEYS

This Appendix summarizes the data collected across 6 seasons of road-based surveys (Oct-Nov 2011, Mar-Apr 2012, Oct-Nov 2012, Mar-Apr 2013, Oct-Nov 2013, Mar-Apr 2014).

Summary of Effort. Vehicular surveys were repeated six times between October 2011 and April 2014 along established survey routes (Figure 1) for a cumulative total of 104 survey days. Surveys were completed in Oct/Nov 2011, Mar/Apr 2012, Oct/Nov 2012, Mar/Apr 2013, Oct/Nov 2013, and Mar/Apr 2014 for the 5 Conservancies. Palmwag Concession was added to our survey area in Oct-Nov 2012 and 4 seasons of surveys have been completed in the Concession. We attempted to complete each transect route once each survey period. In some cases, we repeated transect routes within a season to collect information regarding in-season variability of counts. Repeat surveys have been completed along some transects in Anabeb, Ehirovipuka, and Palmwag.

Over the six seasons, a total of 9890.4 km of routes were surveyed with 1096.9 km of these being surveyed twice during one field season for a total survey effort of 11,029.3 km and 723 hours of observation time. Within Conservancies, the average survey effort ranged from 163 km to 434 km, with an average total survey time ranging between 11 and 32 hours to complete a single set of transect routes (Table I-1). Details of each survey are provided in Table I-2 for surveys in Oct-Nov 2013 and Mar-Apr 2014; prior survey details are provided in Heinemeyer et al. 2013. Over all seasons of surveys, the average transect route was 44.0 km but was variable (range: 7 – 95 km) and took an average of 2.93 hours to complete (range 0.53 – 3.2 hrs.). As per protocol, surveys started in the morning (average start time 7:07) and ended before 11:00 (average end time 10:21) to minimize the potential effects of hot weather on wildlife behavior influencing sightability. The average temperature at the end of surveys was 29˚C (range: 12-44˚C).

Summary of Data. Thirty wildlife species were counted during the six vehicular game count surveys (Table I-3). During all surveys, most prevalent species included Springbok, Hartmann's Mountain Zebra, and Gemsbok, and these species tend to have higher average counts per kilometer of survey effort (Table I-4). These species were relatively common across most Conservancies and abundant in some Conservancies (Table I-5a-d). Other species found in lower numbers in most Conservancies including Giraffe and Ostrich. Noteworthy sightings included a caracal and a group of eight cheetah in Anabeb, a herd of 17 red hartebeest in Torra, 3 bat-eared foxes and a leopard in Sesfontein.

Group composition data including age class and sex was analyzed for common species (Table I-6). However, group compositions were only calculated for groups in which all individuals were accounted for. The identification of age class/sex was difficult to obtain for larger groups so group composition data are biased toward smaller groups. Age structure can be an important indicator of population, particularly if the proportional age structure of the population changes through time. Additional data and additional analyses are required before interpreting the data collected to date as part of the game count surveys.

Approximately 10% of the data used in population analyses were collected on animals fleeing at first observation (Table I-7, see prior survey information in Heinemeyer et al. 2013). This could have some influence on the population analyses based on spatial density such as distance analyses (Buckland et al. 2001), but the low rate of occurrence likely minimizes the effects.

Table I- 1. Summary of vehicular survey efforts completed in 5 Conservancies and the Palmwag Concession in the Kunene region of northern Namibia during 6 seasonal surveys between October 2011 and April 2014.

Conservancy/ Concession	Total Survey Routes	Average (Range) Survey Distance/Field Season (Km)	Average Survey Time/Field Season (Hours)
Anabeb*	6	202.3 (163-234)	12.8 (11.0-14.9)
Ehirovipuka*	6	280.4 (234-304)	17.6 (16.2-19.4)
Omatendeka	6	247.1 (214-324)	16.7 (14.9-18.1)
Palmwag*	12	426.3 (372-471)	28.3 (24.1-31.6)
Sesfontein	6	271.3 (201-314)	14.8 (13.0-17.9)
Torra	9	367.5 (256-434)	27.1 (17.7-32.4)

*A portion of routes in this Conservancy/Concession were repeated more than once during at least one field season, which is not accounted for in this table: Anabeb 6 routes; Ehirovipuka 2 routes,; Palmwag 7 routes on the first repeated circuit, 9 routes on the second

Table I- 2. Summary of vehicular game count survey effort completed between October 2013 and April 2014 in the Kunene region of Namibia.

Conservancy/ Concession	Rt ID	Date	Start Time	Start Temp	End Time	End Temp	Distance Travelled (km)	Survey Time (HR:MIN)
Torra	7	4-Oct-2013	7:00	25	10:50	32	47	3:50
Torra	5	4-Oct-2013	7:00	25	10:44	32	46	3:44
Torra	4	6-Oct-2013	7:02	25	9:25	32	39	2:23
Torra	2	6-Oct-2013	7:00	19	9:33	36	30	2:33
Torra	6	7-Oct-2013	7:01	19	10:25	25	41	3:24
Palmwag	2	9-Oct-2013	7:05	22	9:24	32	32	2:19
Palmwag	4	9-Oct-2013	7:06	12	9:21	22	46.00	2:15
Torra	3	10-Oct-2013	7:00	16	10:44	22	54.00	3:44
Torra	1	11-Oct-2013	7:03	14	9:50	18	48.00	2:47
Torra	8	11-Oct-2013	7:00	24	9:50	31	51.00	2:50
Anabeb	2	16-Oct-2013	7:05	20	9:44	29	45.00	2:39
Anabeb	1	16-Oct-2013	7:15	20	10:33	29	83.00	3:18
Anabeb	3	17-Oct-2013	7:01	19	9:16	25	25.00	2:15
Anabeb	4	17-Oct-2013	7:00	22	10:42	30	52.00	3:42
Sesfontein	4	19-Oct-2013	7:00	20	9:36	23	61.00	2:36
Sesfontein	5	19-Oct-2013	7:00	18	8:56	22	32.00	1:56
Sesfontein	6	21-Oct-2013	7:03	10	9:37	20	95.00	2:34
Sesfontein	1	23-Oct-2013	7:10	8	9:12	15	39.10	2:02
Sesfontein	2	23-Oct-2013	7:09	8	9:49	28	50.00	2:40
Sesfontein	3	24-Oct-2013	7:10	10	9:04	19	37.00	1:54
Ehirovipuka	5	1-Nov-2013	7:00	9	8:00	13	18.00	1:00
Ehirovipuka	1	1-Nov-2013	7:00	14	10:49	22	91.50	3:49
Ehirovipuka	3	3-Nov-2013	7:15	15	10:56	32	57.00	3:41
Ehirovipuka	2	3-Nov-2013	7:00	9	10:36	19	65.00	3:36
Ehirovipuka	4	5-Nov-2013	7:21	17	10:33	30	35.00	3:12
Ehirovipuka	6	5-Nov-2013	7:01	14	9:50	33	37.00	2:49
Omatendeka	3	18-Nov-2013	7:03	13	10:40	31	40.00	3:37
Omatendeka	2	18-Nov-2013	7:03	12	10:44	31	55.00	3:41
Omatendeka	1	19-Nov-2013	7:08	15	9:39	25	55.00	2:31
Omatendeka	4	20-Nov-2013	7:02	12	9:30	27	37.00	2:28
Omatendeka	5	20-Nov-2013	7:07	13	11:00	24	30.00	3:53
Omatendeka	6	21-Nov-2013	7:00	13	8:16	24	8.00	1:16
Palmwag	8	24-Nov-2013	7:08	13	9:36	28	40.00	2:28
Palmwag	6	24-Nov-2013	7:05	9	9:00	23	40.00	1:55
Palmwag	7	25-Nov-2013	7:00	12	10:16	25	63.00	3:16
Palmwag	1	25-Nov-2013	7:02	8	9:57	25	39.00	2:55
Palmwag	10	26-Nov-2013	7:06	15	10:30	24	47.00	3:24
Palmwag	5	27-Nov-2013	7:23	15	10:04	25	34.00	2:41
Palmwag	12	28-Nov-2013	7:17	15	8:41	27	17.00	1:24
Palmwag	11	28-Nov-2013	7:02	16	9:30	28	35.00	2:28

Torra	7	9-Mar-2014	7:00	20	10:38	34	36	3:38
Torra	5	9-Mar-2014	7:00	18	10:15	22	47	3:15
Palmwag	2	10-Mar-2014	7:03	15	11:00	30	34	3:57
Palmwag	4	10-Mar-2014	7:00	14	9:29	19	44	2:29
Torra	2	12-Mar-2014	7:00	18	10:03	21	37	3:03
Torra	6	12-Mar-2014	7:03	15	10:33	28	31	3:30
Torra	4	13-Mar-2014	7:00	12	8:43	9	40	1:43
Torra	1	15-Mar-2014	7:00	21	9:18	26	42	2:18
Torra	8	15-Mar-2014	7:00	24	10:34	28	51	3:34
Torra	3	16-Mar-2014	7:00	22	10:35	30	55	3:35
Anabeb	2	21-Mar-2014	7:20	18	8:50	36	30	1:30
Anabeb	1	21-Mar-2014	7:10	25	11:00	37	66	3:50
Anabeb	3	22-Mar-2014	7:12	25	9:39	30	26	2:27
Anabeb	4	22-Mar-2014	7:00	25	10:10	29	41	3:10
Sesfontein	6	24-Mar-2014	7:02	25	10:15	27	95	3:13
Sesfontein	5	24-Mar-2014	7:00	24	9:32	21	32	2:32
Sesfontein	4a	26-Mar-2014	7:00	19	7:36	17	14	0:36
Sesfontein	4b	26-Mar-2014	7:02	25.5	10:37	38	35	3:35
Sesfontein	3	29-Mar-2014	7:01	19	8:47	25	36	1:46
Sesfontein	1	30-Mar-2014	7:00	21	10:11	32	38	3:11
Sesfontein	2	30-Mar-2014	7:07	18	10:08	30	51	3:01
Palmwag	9	9-Apr-2014	7:16	24	8:51	31	33	1:35
Palmwag	3	9-Apr-2014	7:00	23	10:40	36	57	3:40
Palmwag	10	10-Apr-2014	7:00	23	10:11	28	48	3:11
Palmwag	5	10-Apr-2014	7:00	23	9:43	31	34	2:43
Palmwag	12	11-Apr-2014	7:00	22	7:56	25	17	0:56
Palmwag	11	11-Apr-2014	7:00	24	8:32	26	35	1:32
Palmwag	1	12-Apr-2014	7:00	24	9:51	26	40	2:51
Palmwag	7	12-Apr-2014	7:00	23	10:30	28	77	3:30
Palmwag	6	13-Apr-2014	7:00	26	8:57	34	12	1:57
Palmwag	8	13-Apr-2014	7:03	24	9:08	31	40	2:05
Ehirovipuka	5	23-Apr-2014	7:06	17	8:17	25	21	1:11
Ehirovipuka	1	23-Apr-2014	7:02	15	10:47	32	91	3:45
Ehirovipuka	2	24-Apr-2014	7:00	14	10:01	31	58	3:01
Ehirovipuka	3	24-Apr-2014	7:06	16	9:51	28	56	2:45
Ehirovipuka	4	26-Apr-2014	7:02	20	9:08	29	31	2:06
Ehirovipuka	6	26-Apr-2014	7:03	16	10:29	29	40	3:26
Omatendeka	3	28-Apr-2014	7:00	18	10:41	35	72	3:41
Omatendeka	2	28-Apr-2014	7:00	21	10:01	31	54	3:01
Omatendeka	1	29-Apr-2014	7:17	22	9:10	29	44	1:53
Omatendeka	4	30-Apr-2014	7:02	18	9:30	32	36	2:28
Omatendeka	5	30-Apr-2014	7:01	17	10:18	33	26	3:17
Omatendeka	6	1-May-2014	7:00	16	7:32	25	7	0:32

Table I- 3. Total counts of species recorded during vehicular game counts in 5 Conservancies and Palmwag Concession in the Kunene region of northern Namibia from October 2011 through April 2014.

Species	**Latin Name**	**Oct- Nov 2011**	**Mar-Apr 2012**	**Oct-Nov 2012**	**Mar-Apr 2013**	**Oct-Nov 2013**	**Mar-Apr 2014**
Aardwolf	*Proteles cristatus*	2			1	2	
African wildcat	*Felis libyca*				3		1
Bat-eared fox	*Otocyon megalotis*		3	5	6		
Black-backed jackal	*Canis mesomelas*	21	28	40	57	24	34
Black-faced impala	*Aepyceros melampus pertersi*						8
Brown hyena	*Hyaena brunnea*				1		
Caracal	*Caracal caracal*		1		1		
Chacma baboon	*Papio ursinus*	141	72	153	121	75	49
Cheetah	*Acinonyx jubatus*		4		2		8
Dik-dik	*Madoqua kirkii*	4				4	
Duiker	*Sylvicapra grimmia*				2		
Eland	*Taurotragus oryx*	17	4			30	
Elephant	*Loxodonta africana*	10	2	21	53	18	1
Gemsbok	*Oryx gazella*	942	1079	1361	1106	681	575
Giraffe	*Giraffa camelopardalis*	159	195	253	282	247	183
HM Zebra	*Equus Zebra hartmannae*	1251	1920	1952	2009	641	1761
Honey badger	*Mellivora capensis*	1			1	1	
Klipspringer	*Oreotragus oreotragus*		4		7	10	
Kudu	*Tragelaphus strepsicerus*	141	60	175	111	106	35
Leopard	*Panthera pardis*		1				
Lion	*Panthera leo*			5	10	13	1
Ostrich	*Struthio camelus*	116	294	262	331	178	158
Red hartebeest	*Alcelaphus caama*		17		14	10	6
Rock hyrax	*Procavia capensis*	11	4		23	12	
Spotted hyena	*Crocuta crocuta*	2	1	3	4		1
Springbok	*Antidorcas marsupialis*	1385	2956	3213	3487	1863	3954
Steenbok	*Raphicerus campestris*	19	22	59	39	59	11
Warthog	*Phacochoerus africanus*		6		6		1

Table I- 4. Average counts per survey kilometer of seven common species in each of six field seasons in Anabeb, Ehirovipuka, Omatendeka, Sesfontein, and Torra Conservancies Oct 2011- Apr 2014, including Palmwag Concession Oct 2012- Apr 2014.

Species	Latin Name	Oct- Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Chacma baboon	*Papio ursinus*	0.0922	0.0458	0.0765	0.0497	0.0405	0.0271
Gemsbok	*Oryx gazella*	0.6189	0.6864	0.6810	0.4953	0.3674	0.3178
Giraffe	*Giraffa camelopardalis*	0.1046	0.1240	0.1265	0.1263	0.1333	0.1011
HM Zebra	*Equus Zebra hartmannae*	0.8176	1.2214	0.9755	0.9000	0.3458	0.9733
Kudu	*Tragelaphus strepsicerus*	0.0922	0.0382	0.0875	0.0497	0.0572	0 0193
Ostrich	*Struthio camelus*	0.0758	0.1870	0.1310	0.1482	0 0960	0.0873
Springbok	*Antidorcas marsupialis*	0.9052	1.8804	1.6085	1.5615	1.0051	0.2215

Table I-5a. Total counts of common species observed on vehicular game routes during Oct-Nov 2011.

		Conservancy (transect distance (km))				
Common Name	**Latin Name**	**Anabeb (234)**	**Ehirovipuka (234)**	**Omatendeka (324)**	**Sesfontein (288)**	**Torra (369)**
Chacma baboon	*Papio ursinus*	29	36	0	30	46
Gemsbok	*Oryx gazella*	69	80	266	140	392
Giraffe	*Giraffa camelopardalis*	7	81	22	9	41
HM Zebra	*Equus Zebra hartmannae*	207	96	227	85	636
Kudu	*Tragelaphus strepsicerus*	19	4	7	0	111
Ostrich	*Struthio camelus*	10	7	4	51	44
Springbok	*Antidorcas marsupialis*	226	4	257	257	641

Table I-5b. Total counts of common species observed on vehicular game routes during Mar-Apr 2012.

		Conservancy (transect distance (km))				
Common Name	**Latin Name**	**Anabeb (227)**	**Ehirovipuka (281)**	**Omatendeka (214)**	**Sesfontein (251)**	**Torra (415)**
Chacma baboon	*Papio ursinus*	32	5	0	0	35
Gemsbok	*Oryx gazella*	68	66	261	244	440
Giraffe	*Giraffa camelopardalis*	16	109	46	4	20
HM Zebra	*Equus Zebra hartmannae*	578	251	615	38	438
Kudu	*Tragelaphus strepsicerus*	7	6	13	0	34
Ostrich	*Struthio camelus*	44	13	122	34	81
Springbok	*Antidorcas marsupialis*	1259	102	374	151	1070

Table I-5c. Total counts of common species observed on vehicular game routes during Oct-Nov 2012.

		Conservancy/Concession (transect distance (km))					
Common Name	**Latin Name**	**Anabeb (229)**	**Ehirovipuka (293)**	**Omatendeka (226)**	**Palmwag (337)**	**Sesfontein (201)**	**Torra (364)**
Chacma baboon	*Papio ursinus*	40	0	0	29	29	55
Gemsbok	*Oryx gazella*	23	94	107	663	143	332
Giraffe	*Giraffa camelopardalis*	2	46	64	91	11	39
HM Zebra	*Equus Zebra hartmannae*	44	76	210	1241	15	365
Kudu	*Tragelaphus strepsicerus*	21	23	32	62	0	37
Ostrich	*Struthio camelus*	5	10	7	102	46	92
Springbok	*Antidorcas marsupialis*	457	292	505	1410	136	417

Table I-5d. Total counts of common species observed on vehicular game routes during Mar-Apr 2013.

		Conservancy/Concession (transect distance (km))					
Common Name	**Latin Name**	**Anabeb (201)**	**Ehirovipuka (288)**	**Omatendeka (254)**	**Palmwag (449)**	**Sesfontein (272)**	**Torra (355)**
Chacma baboon	*Papio ursinus*	2		65		15	29
Gemsbok	*Oryx gazella*	18	3	42	670	117	256
Giraffe	*Giraffa camelopardalis*	19	92	70	75	8	18
HM Zebra	*Equus Zebra hartmannae*	167	217	41	1059	120	405
Kudu	*Tragelaphus strepsicerus*	10	0	5	69	0	27
Ostrich	*Struthio camelus*	13	13	26	153	20	106
Springbok	*Antidorcas marsupialis*	386	171	901	1448	133	448

Table I- 6. Age class/sex composition for identified groups of the seven most common species in Anabeb, Ehirovipuka, Omatendeka, Sesfontein, Torra Conservancies and Palmwag Concession in the Kunene region. Percentages describe the total number of groups counted which were included in the composition numbers; n= number of groups in which ages and sex were recorded, A = Adult, SA = Subadult, YoY = Young of Year.

Field Season	Species	Groups Counted	Mean Group Size	Range Group Size	Age Class Composition				Sex Ratio		
					A	SA	YoY	N	Male	Female	N
Oct-Nov 2011	Chacma baboon	13	10.9	1-23	3.60	1.83	1.33	6 (46%)	-	-	1 (8%)
	Gemsbok	232	4.08	1-40	2.87	0.08	0.15	131 (56%)	1	1.2	86 (37%)
	Giraffe	50	3.20	1-13	2.39	0.34	0.39	40 (80%)	1	1.0	24 (48%)
	HM Zebra	168	7.45	1-40	5.59	0.45	0.30	71 (42%)	1	1.8	22 (13%)
	Kudu	30	4.70	1-20	3.82	0.59	0.06	17 (57%)	1	1.4	23 (77%)
	Ostrich	54	2.15	1-13	1.73	0.04	0	48 (77%)	1	0.5	47 (87%)
	Springbok	194	7.14	1-64	3.60	0.33	0.50	98 (51%)	1	1.2	61 (31%)
Mar-Apr 2012	Chacma baboon	7	10.3	2-30	5.33	2.00	4.00	3 (43%)	-	-	0
	Gemsbok	211	5.11	1-103	2.54	0.38	0.28	112 (53%)	1	1.0	60 (28%)
	Giraffe	53	3.68	1-16	2.00	0.38	0.15	13 (25%)	1	0.2	21 (40%)
	HM Zebra	258	7.44	1-150	4.88	0,69	0.47	65 (25%)	1	2.3	8 (3%)
	Kudu	27	2.22	1-7	1.92	0.04	0.08	24 (89%)	1	1.2	26 (96%)
	Ostrich	46	6.39	1-49	3.5	0.35	0.24	34 (74%)	1	0.7	29 (63%)
	Springbok	190	15.4	1-208	3.58	0.68	0.31	77 (41%)	1	1.3	45 (24%)
Oct-Nov 2012	Chacma baboon	8	19.1	1-40	9.00	2.75	2.25	4 (50%)	-	-	0
	Gemsbok	308	3.63	1-33	2.31	0.22	0.17	193 (63%)	1	0.9	119 (39%)
	Giraffe	73	3.14	1-15	2.23	0.52	0.38	64 (88%)	1	1.1	27 (37%)
	HM Zebra	210	8.13	1-45	4.26	0.75	0.69	88 (42%)	1	1.4	22 (10%)
	Kudu	36	4.02	1-12	2.91	0.63	0.22	32 (89%)	1	2.1	28 (78%)
	Ostrich	73	3.10	1-21	2.56	0.11	0	66 (90%)	1	0.7	59 (81%)
	Springbok	111	7.40	1-62	4.47	0.91	0.15	211 (55%)	1	1.5	111 (29%)
Mar-Apr 2013	Chacma baboon	10	7.50	1-17	3.67	2.33	1.11	9 (90%)	1	0	3 (30%)
	Gemsbok	298	2.65	1-23	2.33	0.19	0.03	296 (99%)	1	0.8	226 (76%)
	Giraffe	67	3.34	1-14	2.43	0.51	0.24	63 (94%)	1	0.8	48 (72%)
	HM Zebra	168	5.56	1-27	4.23	0.84	0.16	159 (95%)	1	1.6	35 (21%)
	Kudu	39	2.85	1-10	2.23	0.51	0.13	39 (100%)	1	1.3	36 (92%)
	Ostrich	71	4.15	1-14	3.89	0	0.27	71 (100%)	1	0.8	66 (93%)
	Springbok	264	3.77	1-34	3.10	0.25	0.31	258 (98%)	1	0.9	141 (53%)
Oct-Nov 2013	Chacma baboon	8	9.38	3-24	6.75	3.25	0.75	4 (50%)	1	1.6	3 (38%)
	Gemsbok	233	2.92	1-23	2.66	0.09	0.08	175 (75%)	1	1.8	143 (61%)
	Giraffe	88	2.81	1-13	2.03	0.34	0.14	71 (81%)	1	1.1	50 (57%)

	HM Zebra	141	4.55	1-24	3.57	0.52	0.02	68 (48%)	1	2.4	39 (28%)
	Kudu	28	3.79	1-12	3.14	0.70	0	27 (96%)	0	-	11 (39%)
	Ostrich	50	3.56	1-13	3.51	0	0	49 (98%)	1	0.8	49 (98%)
	Springbok	379	4.94	1-30	4.34	0.34	0.02	233 (61%)	1	2.0	194 (51%)
Mar-Apr	Chacma baboon	4	12.3	1-23	1	0	0	1 (25%)	-	-	1 (25%)
2014	Gemsbok	119	4.83	1-57	3.15	0.21	0	89 (75%)	1	2.4	66 (55%)
	Giraffe	42	4.36	1-18	2.70	0.72	0.16	33 (78%)	1	0.4	22 (52%)
	HM Zebra	236	7.46	1-39	4.63	0.43	0.02	111 (47%)	1	2.2	55 (23%)
	Kudu	8	4.38	1-7	3.63	1	0	8 (100%)	1	2.3	6 (75%)
	Ostrich	66	2.39	1-15	2.12	0	0.24	64 (97%)	1	0.8	58 (88%)
	Springbok	325	12.17	1-228	4.15	0.36	0.48	175 (54%)	1	0.7	124 (38%)

Table I-7. Instances where animals were first observed fleeing or with the assistance of binoculars during vehicular game counts in the Kunene region of northern Namibia (n= total number of animal groups by species and field season).

Field Season	Species	Groups fleeing upon observation	Groups sited with binoculars	N
Oct-Nov 2013	Chacma baboon	1 (13%)	0	8
	Gemsbok	32 (14%)	1 (<1%)	233
	Giraffe	5 (6%)	0	88
	HM Zebra	10 (7%)	0	141
	Kudu	5 (18%)	1 (4%)	28
	Ostrich	3 (6%)	0	50
	Springbok	32 (8%)	1 (<1%)	377
Mar-Apr 2014	Chacma baboon	1 (25%)	0	4
	Gemsbok	10 (8%)	2 (2%)	119
	Giraffe	0	0	42
	HM Zebra	29 (12%)	0	236
	Kudu	0	0	8
	Ostrich	10 (15%)	1 (2%)	66
	Springbok	15 (5%)	1 (<1%)	325

APPENDIX II: ADDITIONAL INFORMATION FOR POPULATION MODELING

This Appendix provides additional table summaries of population analyses and modeling details as referred to in the main report.

Gemsbok

Table II-1. Summary of data and distance sampling analyses of Gemsbok across 6 seasonal surveys completed in 5 communal Conservancies in the Kunene region of northern Namibia.

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1000m	1000m	1000m	1000m	1200m	1200m
Effort (km)	1484	1340	1313	1370	1927	1568
# Groups	215	175	186	133	140	75
Total Count	888	951	666	436	398	326
Key Function, adjustment	Hazard rate	Half-normal, 2 cosine	Uniform, 3 cosine	Half-normal	Hazard rate, 4 polynomial	Hazard rate, 1 polynomial
K-S[1] or Chi-sq test p-value[2]	0.76	0.63[3]	0.87	0.999	0.99	0.98
Cluster Size + SE[4]	4.1 + 0.38	5.43 + 0.77	3.67 + 0.32	3.23 + 0.44	2.77 + 0.21	3.96+0.59
ESW[1]	360	336	280	389	196	572
Density %CV[1]	25	30.0	24.9	28.2	27.2	32.3

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov
[2] Kolmogorov-Smirnov test is provided where data are input into analyses as individual distance data and the probability of a greater chi-square value is provided in instances where data are pooled into distance classes; each represents an evaluation of model fit appropriate to the form of the data input.
[3] Probability of a greater chi-square; used when data are pooled into distance classes
[4] Cluster size is the average cluster size for surveys prior to Oct 2013 and is the expected cluster size based on regression results for results in Oct-Nov 2013 and beyond

Table II-2. Summary of data and distance sampling analyses of Gemsbok across 4 seasonal surveys completed in 5 communal Conservancies and Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1000m	1000m	1200m	1200m
Effort (km)	1741	1804	1927	2057
# Groups	285	251	222	118
Total Count	1044	790	643	574
Key Function, adjustment	Half-normal, 2 cosine	Hazard rate, 4 polynomial	Hazard rate, 4 polynomial	Half-normal
K-S[1] or Chi-sq test p-value[2]	0.55[3]	0.56	0.99	0.74
Cluster Size + SE[4]	3.66 + 0.26	3.15 + 0.29	2.84+0.18	3.81+0.47
ESW[2]	310	272	223	453
Density %CV[1]	18.8	23.8	21.4	24.4

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov

[2] Kolmogorov-Smirnov test is provided where data are input into analyses as individual distance data and the probability of a greater chi-square value is provided in instances where data are pooled into distance classes; each represents an evaluation of model fit appropriate to the form of the data input.

[3] Probability of a greater chi-square; used when data are pooled into distance classes

[4] Cluster size is the average cluster size for surveys prior to Oct 2013 and is the expected cluster size based on regression analyses for Oct-Nov 2013 and beyond

Table II-3. Population estimates for Gemsbok within each of 5 Conservancies and the Palmwag Concession for each of 6 survey periods.

Gemsbok Pop. Est.[1]	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Anabeb	**333**	**207**	**125**	**127**	**236**	**20**
Ehirovipuka	**356**	**700**	**1072**	**35**	**640**	**24**
Omatendeka	**1217**	**1496**	**830**	**274**	**211**	**41**
Palmwag			4502	5188	3414	1218
Sesfontein	1268	1396	1515	1415	1060	**312**
Torra	3181	4326	3401	2393	2179	697

[1] Population estimate method is either distance-based modeling in normal font or strip transect analyses in bold font.

Hartmann's Mountain Zebra

Table II-4. Summary of data and distance sampling analyses of Hartmann's Mountain Zebra across 6 seasonal surveys completed 5 communal Conservancies, excluding Palmwag Concession, in the Kunene region of northern Namibia.

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1500m	1200m	1200m	1200m	1200m	1200m
Effort (km)	1483	1340	1313	1370	1927	1568
# Groups	159	208	86	133	98	169
Total Count	1189	1621	647	946	388	1181
Key Function, adjustment	Half-normal, 2 cosine	Half-normal, 2 cosine	Half-normal	Hazard rate, 4 poly	Hazard rate	Half-normal
K-S[1] or Chi-sq test p-value[2]	0.76	0.63[3]	0.87	0.999	0.89	0.63
Cluster Size + SE[4]	7.04 + 0.46	7.79 + 0.85	7.59 + 0.64	6.91 + 0.54	3.56+0.36	7.25+0.44
ESW[2]	516	463	375	259	194.96	428
Density %CV[1]	28.7	31.8	34	30.2	37.5	28.8

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov

[2] Kolmogorov-Smirnov test is provided where data are input into analyses as individual distance data and the probability of a greater chi-square value is provided in instances where data are pooled into distance classes; each represents an evaluation of model fit appropriate to the form of the data input.

[3] Probability of a greater chi-square; used when data are pooled into distance classes

[4] Cluster size is the average cluster size for surveys prior to Oct 2013 and is the expected cluster size based on regression analyses for Oct-Nov 2013 and beyond

Table II-5. Summary of data and distance sampling analyses of Hartmann's Mountain Zebra across 6 seasonal surveys completed in 5 communal Conservancies and Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1000m	1200m	1200m	1200m
Effort (km)	1741	1804	1927	2057
# Groups	184	227	132	236
Total Count	1545	1597	590	1761
Key Function, adjustment	Half-normal, 2 cosine	Half-normal, 2 cosine	Hazard rate	Half-normal
K-S[1] or Chi-sq test p-value[2]	0.73[3]	0.56	0.80	0.73
Cluster Size + SE[4]	8.88 + 0.53	6.91 + 0.43	4.11+0.36	7.56+0.42
ESW[2]	377	382	242	397
Density %CV[1]	27.3	21	37.5	24.7

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov

[2] Kolmogorov-Smirnov test is provided where data are input into analyses as individual distance data and the probability of a greater chi-square value is provided in instances where data are pooled into distance classes; each represents an evaluation of model fit appropriate to the form of the data input.

[3] Probability of a greater chi-square; used when data are pooled into distance classes

[4] Cluster size is the average cluster size for surveys prior to Oct 2013 and is the expected cluster size based on regression analyses for Oct-Nov 2013 and beyond

Table II-6. Population estimates for Zebra within each of 5 Conservancies and the Palmwag Concession for each of 6 survey periods.

Zebra Pop. Est.[1]	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Anabeb	860	2048	**196**	**836**	**109**	**1590**
Ehirovipuka	**523**	**1616**	**557**	3223	**1388**	**115**
Omatendeka	**656**	**3001**	**1192**	**204**	237	**950**
Palmwag			8336	6523	1890	4294
Sesfontein	**543**	436	**134**	**783**	**538**	**853**
Torra	2909	2978	3181	4486	951	3098

[1] Population estimate method is either distance-based modeling in normal font or strip transect analyses in bold font.

Springbok

Table II-7. Summary of data and distance sampling analyses of Springbok across 6 seasonal surveys completed in 5 communal Conservancies, excluding Palmwag Concession, in the Kunene region of northern Namibia.

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	>5%	1000m	1000m	1000m	1000m	1000m
Effort (km)	1483.5	1340.4	1313.0	1370.0	1927.0	1568.1
# Groups	180	132	257	189	273	178
Total Count	1294	2404	1743	2039	1300	1903
Key Function, adjustment	Hazard rate	Hazard rate, 4 poly orders	Hazard rate, 4 poly orders	Hazard rate, 4 poly orders	Hazard rate, 1 poly orders	Half-normal, 2 cosine
K-S[1] or Chi-sq test p-value[2]	0.87	0.99	0.84	0.69	0.44[3]	0.95[3]
Cluster Size + SE[4]	7.2 + 0.80	18.2 + 2.81	6.8 + 0.38	6.7 + 0.80*	4.7+0.29	11.5+1.48
ESW[2]	266	203	189	169	145	234
Density %CV[1]	22.9	30.7	18.3	25.2	24.0	44.4

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov
[2] Kolmogorov-Smirnov test is provided where data are input into analyses as individual distance data and the probability of a greater chi-square value is provided in instances where data are pooled into distance classes; each represents an evaluation of model fit appropriate to the form of the data input.
[3] Probability of a greater chi-square; used when data are pooled into distance classes
[4] Cluster size is the average cluster size for surveys prior to Mar 2013 and is the expected cluster size based on regression analyses thereafter.

Table II-8. Summary of data and distance sampling analyses of Springbok across 6 seasonal surveys completed in 5 communal Conservancies and Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1000m	1000m	1000m	780m
Effort (km)	1741.0	1340.4	2430.8	3057.2
# Groups	360	284	361	312
Total Count	2615	2810	1743	3481
Key Function, adjustment	Half-normal, 3 cosine	Hazard rate, 4 poly orders	Hazard rate, 3 poly orders	Hazard rate, 4 poly orders
K-S[1] or Chi-sq test p-value[2]	0.91	0.79	0.59[3]	0.57[3]
Cluster Size + SE[4]	7.3 + -.39	6.85 + 2.0	4.7+0.26	9.9+1.02
ESW[2]	206	189	162	234
Density %CV[1]	15	19.9	21.26	32.0

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov

[2] Kolmogorov-Smirnov test is provided where data are input into analyses as individual distance data and the probability of a greater chi-square value is provided in instances where data are pooled into distance classes; each represents an evaluation of model fit appropriate to the form of the data input.

[3] Probability of a greater chi-square; used when data are pooled into distance classes

[4] Cluster size is the average cluster size for surveys prior to Oct 2013 and is the expected cluster size based on regression results for results in Oct-Nov 2013 and beyond

Table II-9. Population estimates for Springbok within each of 5 Conservancies and the Palmwag Concession for each of 6 survey periods.

Springbok Pop. Est.[1]	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Anabeb	**1308**	7193	4859	4024	2251	2180
Ehirovipuka	**51**	**1504**	**3734**	**2511**	**3949**	**12**
Omatendeka	1129	4163	4002	1767	2029	1126
Palmwag			13984	13073	8069	18712
Sesfontein	2548	3866	2619	2712	1018	**8050**
Torra	6564	12115	8250	8561	4985	3822

[1] Population estimate method is either distance-based modeling in normal font or strip transect analyses in bold font.

Kudu

Table II-10. Summary of data and distance sampling analyses of Kudu across 6 seasonal surveys completed in 5 communal Conservancies, excluding Palmwag Concession, in the Kunene region of northern Namibia.

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1000m	1000m	1000m	1000m	800m	-
Effort (km)	1483.5	1340.4	1313	1370	1927.0	2057.2
# Groups	28	23	28	17	16	8
Total Count	133	54	112	42	54	35
Key Function, adjustment	Half-normal	Hazard rate	Hazard rate, poly 4	Half-normal	Half-normal	-
K-S[1] or Chi-sq test p-value[2]	0.97	0.99	0.998	0.31	0.44[3]	-
Cluster Size + SE[4]	4.75 + 0.88	1.56 + 0.26*	4.0 + 0.61	2.5 + 0.35	3.1+0.70	
ESW[2]	240	168	138	129	272	241
Density %CV[1]	47.3	49.3	55.2	40.2	49.7	-

**Estimates based on strip transect analyses using the ESW and associated assumptions, not distance-based modeling

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov
[2] Kolmogorov-Smirnov test is provided where data are input into analyses as individual distance data and the probability of a greater chi-square value is provided in instances where data are pooled into distance classes; each represents an evaluation of model fit appropriate to the form of the data input.
[3] Probability of a greater chi-square; used when data are pooled into distance classes
[4] Cluster size is the average cluster size for surveys prior to Oct 2013, except for Mar-Apr 2012; for this season and all seasons from Oct 2013 on, the expected cluster size is based on regression analyses

Table II-11. Summary of data and distance sampling analyses of Kudu across 6 seasonal surveys completed in 5 communal Conservancies including Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1000m	1000m	800m	
Effort (km)	1741.0	1804.0	2430.8	2057.2
# Groups	36	27	25	8
Total Count	144	34	93	35
Key Function, adjustment	Hazard rate, poly 4	Hazard rate	Hazard rate	-
K-S[1] or Chi-sq test p-value[2]	0.997	0.82	0.75[3]	-
Cluster Size + SE[4]	4.0 + 0.51	2.2 + 0.25	3.8+0.64	-
ESW[2]	114	256	145	241
Density %CV[1]	53.6	44.7	58.01	-

**Estimates based on strip transect analyses using the ESW and associated assumptions, not distance-based modeling

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov

[2] Kolmogorov-Smirnov test is provided where data are input into analyses as individual distance data and the probability of a greater chi-square value is provided in instances where data are pooled into distance classes; each represents an evaluation of model fit appropriate to the form of the data input.

[3] Probability of a greater chi-square; used when data are pooled into distance classes

[4] Cluster size is the average cluster size for surveys prior to Oct 2013 and is the expected cluster size based on regression results for results in Oct-Nov 2013 and beyond

Table II-12. Population estimates for Kudu within each of 5 Conservancies and the Palmwag Concession for each of 6 survey periods.

Kudu Pop. Est.[1]	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Anabeb	**161**	**13**	**309**	**75**	**0**	**69**
Ehirovipuka	**57**	**107**	**550**	**0**	**136**	**89**
Omatendeka	**43**	**175**	**601**	**37**	**102**	0
Palmwag			**1080**	**252**	**879**	0
Sesfontein	0	0	0	0	**103**	0
Torra	**1254**	**622**	**1167**	**283**	**476**	**221**

[1] Population estimate method is either distance-based modeling in normal font or strip transect analyses in bold font.

Giraffe

Table II-13. Modeling parameters and summary results for regional Giraffe population estimates across 6 seasonal surveys in 5 communal Conservancies, excluding Palmwag Concession, in the Kunene region of northern Namibia

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1000m	1000m	1000m	1000m	1000m	1000m
Effort (km)	1483.5	1340.4	1313.0	1370.0	1927.0	1568.1
# Groups	43	50	53	50	64	36
Total Count	129	192	147	206	173	147
Key Function, adjustment	Hazard rate	Hazard rate	Half-normal, 2 cosine	Half-normal	Hazard rate	Half-normal
K-S[1] p-value	0.96	0.69	0.43	0.09	0.97	0.85
Cluster Size + SE[2]	3.0 + 0.39	3.8 + 0.47	2.3 + 0.22*	4.1 + 0.53	2.6+0.27	2.9+0.48
ESW[2]	245	424	263	432	229	529
Density %CV[1]	44.9	54.8	33.3	34.7	36.7	42.1

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov

[2] Cluster size is the average cluster size for surveys prior to Oct 2013, except for Oct-Nov 2012 (indicated by a star "*"); for this season and all seasons from October 2013 and beyond, the expected cluster size is used based on regression analyses

Table II-14. Modeling parameters and summary results for regional Giraffe population estimates across 6 seasonal surveys and Palmwag Concession in the Kunene region of northern Namibia

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1000m	1000m	1200m	1000m
Effort (km)	1741.0	1804.0	2430.8	2057.2
# Groups	70	60	85	42
Total Count	214	234	231	183
Key Function, adjustment	Hazard rate	Half-normal	Hazard rate	Half-normal
K-S[1] p-value	0.87	0.06	0.94	0.63
Cluster Size + SE[2]	2.5 + 0.22*	3.9 + 0.46	2.6+0.24	3.7+0.60
ESW[2]	235	428	277	497
Density %CV[1]	31.5	30.2	30.4	37.3

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov

[2] Cluster size is the average cluster size for surveys prior to Oct 2013, except for Oct-Nov 2012 (indicated by a star "*"); for this season and all seasons from October 2013 and beyond, the expected cluster size is used based on regression analyses

Table II-15. Population estimates for Giraffe within each of 5 Conservancies and the Palmwag Concession for each of 6 survey periods.

Giraffe Pop. Est.[1]	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Anabeb	**58**	**75**	**14**	**85**	**123**	**11**
Ehirovipuka	**711**	**770**	521	**597**	**230**	**379**
Omatendeka	**134**	**245**	**583**	**307**	**267**	**133**
Palmwag			694	345	**602**	**244**
Sesfontein	**77**	**19**	179	91	**92**	**57**
Torra	429	**138**	305	235	291	**125**

[1] Population estimate method is either distance-based modeling in normal font or strip transect analyses in bold font.

Ostrich

Table 2-16. Summary of data and distance sampling analyses of Ostrich across 6 seasonal surveys completed in 5 communal Conservancies and Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1000m	1000m	1000m	1000m	1000m	1000m
Effort (km)	1483.5	1340.4	1313.0	1370.0	1927.0	1568.1
# Groups	52	39	48	32	35	49
Total Count	113	264	159	173	119	113
Key Function, adjustment	Uniform, 1 cosine order	Half-normal, 2 cosine orders	Half-normal	Half-normal	Uniform, 2 cosine orders	Half-normal, 1 cosine order
K-S[1] p-value	0.44	0.73	0.67	0.91	0.91	0.95
Cluster Size + SE[2]	2.2 + 0.34	6.8 + 1.36	3.3 + 0.51	5.4 + 0.76	3.5+0.54	2.1+0.24
ESW[2]	550	287	305	433	419	340
Density %CV[1]	31.5	34.1	31.2	31.3	37.9	33.5

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov

[2] Cluster size is the average cluster size for surveys prior to Oct 2013 and is the expected cluster size based on regression results for results in Oct-Nov 2013 and beyond

Table 2-17. Summary of data and distance sampling analyses of Ostrich across 6 seasonal surveys completed in 5 communal Conservancies and Palmwag Concession in the Kunene region of northern Namibia.

Variable	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Truncation	1000m	1000m	1000m	1000m
Effort (km)	1741.0	1804.0	2430.8	2057.2
# Groups	69	52	47	61
Total Count	210	254	172	150
Key Function, adjustment	Half-normal	Half-normal	Half-normal	Half-normal, 1 cosine order
K-S[1] p-value	0.66	0.36	0.89	0.97
Cluster Size + SE[2]	3.0 + 0.37	4.9 + 0.51	3.5+0.46	2 2+0.23
ESW[2]	390	473	362	313
Density %CV[1]	23.6	23.3	28.3	27.7

Table II-18. Population estimates for Ostrich within each of 5 Conservancies and the Palmwag Concession for each of 6 survey periods.

Ostrich Pop. Est.[1]	Oct-Nov 2011	Mar-Apr 2012	Oct-Nov 2012	Mar-Apr 2013	Oct-Nov 2013	Mar-Apr 2014
Anabeb	**33**	**236**	**22**	**53**	**38**	**76**
Ehirovipuka	41	**125**	**70**	**76**	**37**	**87**
Omatendeka	**11**	480	**38**	**105**	**15**	**45**
Palmwag			630	784	380	289
Sesfontein	270	319	**398**	**105**	83	361
Torra	162	1089	449	724	606	212

[1] Population estimate method is either distance-based modeling in normal font or strip transect analyses in bold font.

[1] %CV = % Coefficient of Variation; SE = Standard error; ESW = Effective strip width; K-S = Kolmogorov-Smirnov
[2] Cluster size is the average cluster size for surveys prior to Oct 2013 and is the expected cluster size based on regression results for results in Oct-Nov 2013 and beyond

APPENDIX III: FIELD EFFORT AND DATA SUMMARY OF POINT COUNT SURVEYS

This Appendix summarizes the data collected across 6 seasons of point count surveys (Oct-Nov 2011, Mar-Apr 2012, Oct-Nov 2012, Mar-Apr 2013, Oct-Nov 2013, Mar-Apr 2014).

Summary of Effort. Point count surveys were conducted in each of the 6 surveys seasons for a total of 128 point counts sites surveyed in 97 survey days with some days employing 2 teams to conduct 2 surveys in different areas. A total of 46 point count sites were sampled at least once over the 6 season period. Of these, 21 have been selected for repeated sampling and surveys completed at least twice during the study period (Table III-1, Table III-2). A total of 256 hours of survey effort were devoted to point count surveys. Point count sample site locations and characteristics were recorded and survey information for each point count is provided (Table III-2, Table III-3). As per protocol, surveys started in the morning (average start time 7:59) and ended before 11:00 (average end time 9:59). This is intended to minimize the potential effects of hot weather influencing wildlife behavior and sightability. The average temperature at the end of the survey was 32˚C (range: 21 – 46˚C).

Summary of Data. We have observed nineteen different species during the point count surveys over the course of 6 seasonal survey efforts, (Table II-4). Noteworthy sightings included black-faced impala and eland in Ehirovipuka, 3 cheetahs in Torra, and a lion in Palmwag Concession. Hartmann's Mountain Zebra, Gemsbok, and Giraffe were seen across all five Conservancies and in the Concession. In addition to these species, Kudu, Springbok, and Ostrich were also commonly observed species. At this time, we have not conducted additional analyses on the point count survey information, as the within season sample size and cumulative information is limited. We anticipate additional analyses will be possible in the future to supplement transect-based population monitoring efforts.

In Oct-Nov 2013 and Mar-Apr 2014, we observed 10 wildlife species in each season from point count locations (Table III-5, Table III-6). A rare sighting of a brown hyena occurred in Torra in Oct-Nov 2013. In Mar-Apr 2014, we observed a herd of 56 eland at a point count location in Ehirovipuka Conservancy, the size of which we had not observed by any survey method conducted.

Table III-1. Point count field effort from Oct 2011 to Apr 2014 across 5 Conservancies and Palmwag Concession in the Kunene region of northern Namibia; Palmwag Concession surveys from Oct 2012 – April 2014.

Conservancy/ Concession	Identified PC locations	# of locations repeated	Total Time of PC effort (hours)
Anabeb	6	2	28
Ehirovipuka	8	3	26
Omatendeka	7	2	28
Palmwag	5	1	16
Sesfontein	11	6	70
Torra	14	6	82

Table III- 2. Summary of point count game survey sites established during October 2011 to April 2014 in the Kunene region of Namibia

Conservancy	Site ID	Site Quality[1]	Field of View[2]	Location UTM E	Location UTM N	Replications
Anabeb	A1	2	170	374493	7871254	1
	A2	2	182	372805	7885144	1
	A3	2	204	378647	7852010	7
	A4	1	187	373585	7843743	3
	A5	2	221	386664	7833928	3
	A6	2	340	374082	7847997	1
Ehirovipuka	E1	1	212	413408	7818975	2
	E2	3	78	414640	7821517	1
	E3	2	141	411280	7816944	1
	E4-39	1	122	413196	7853766	3
	E5	2	184	413403	7818954	3
	E6	1	136	415061	7842701	1
	E56	2	143	429616	7858721	3
Omatendeka	O1	2	91	409018	7894377	4
	O2	2	126	403866	7872101	1
	O3	3	114	402338	7854837	1
	O4-20	1	147	404000	7821332	5
	O5	2	224	408810	7894560	1
	O6	2	NA	395915	7901220	1
	O57	1	181	403869	7821285	1
Palmwag	P1	1	199	381145	7764250	4
	P2	2	171	381791	7764588	1
	P3	2	205	384143	7768218	1
	P4	3	169	339631	7801785	1
	P5	1	169	326184	7835024	1
Sesfontein	S1	2	160	355472	7888926	1
	S1b	2	70	340911	7876419	1
	S2-7	1	124	307004	7863127	5
	S3-12	1	215	354440	7875962	6
	S4-17	1	158	354182	7866999	4
	S5-21	1	202	339782	7879512	3
	S6	2	219	332495	7901025	4
	S7	3	230	343323	7890099	2
	S8-27	1	182	346818	7893255	6
	S9	1	184	353158	7877927	1
	S10	2	177	323706	7895955	1
	S11	2	172	340914	7876415	1
Torra	T1-4	1	227	380591	7759376	6
	T2-8	1	177	370977	7756368	6

T3	2	120	423052	7746294	1
T4-19	1	181	394488	7728042	6
T5	1	148	377268	7719164	1
T6	3	127	377651	7723718	1
T7	1	292	391683	7794906	1
T8-28	1	164	396521	7786559	6
T9-1	1	281	398660	7779495	6
T10	2	137	402061	7757769	4
T11	1	39	377994	7745910	1
T12	1	206	392058	7789070	1
T13	2	130	383578	7749732	1

[1] Subjective rating from 'High Quality' = 1 to 'Limited Quality' = 3 as an indication of quality of view scape and access restrictions
[2] Field of view is the degree of the angle of view shed
Shaded cells sites indicate more than one repeat and are sites RRCS will focus efforts to replicate in the future.

Table III- 3. Summary of point count game survey effort completed October 2011-April 2014 in the Kunene region of Namibia.

Conservancy	**Date**	**Point ID**	**Temp Start (˚C)**	**Wind Direction[1]**	**Wind Speed (km/hour)**	**Time Start**	**Time End**	**Temp End (˚C)**
Ehirovipuka	12-Oct-2011	E1	NA	E	0-5	7:33	9:33	NA
Ehirovipuka	12-Oct-2011	E2	NA	SE	0-5	8:40	10:40	NA
Torra	15-Oct-2011	T1-4	25.0	S/SE	0-5	8:16	10:16	NA
Torra	16-Oct-2011	T2-8	16.7	W	0-5	8:09	10:09	32.2
Torra	18-Oct-2011	T3	18.0	SW	0-5	7:16	9:16	24.0
Torra	19-Oct-2011	T4-19	17.9	SW	0-5	8:42	10:42	36.8
Torra	20-Oct-2011	T5	21.0	NE	10-15	7:31	9:31	31.0
Torra	20-Oct-2011	T6	21.0	NE	10-15	8:15	10:15	31.0
Torra	22-Oct-2011	T7	24.0	W	5-10	7:41	9:41	32.8
Torra	22-Oct-2011	T8-28	14.8	E	0-5	8:04	10:04	32.8
Torra	23-Oct-2011	T9-1	22.0	None	0	8:03	10:03	34.0
Anabeb	27-Oct-2011	A1	26.0	NE	0-5	7:50	9:50	32.0
Anabeb	27-Oct-2011	A2	26.0	NE	0-5	7:46	9:46	32.0
Anabeb	29-Oct-2011	A3	23.0	W/NW	0-5	7:50	9:50	36.0
Anabeb	29-Oct-2011	A4	26.4	NE	0-5	8:00	10:00	33.7
Sesfontein	30-Oct-2011	S1	23.0	SW	0-5	7:37	9:37	NA
Sesfontein	1-Nov-2011	S2-7	21.3	W	0-5	8:29	10:29	34.4
Sesfontein	3-Nov-2011	S3-12	NA	None	0	7:51	9:51	46.0
Sesfontein	3-Nov-2011	S4-17	36.7	N	0-5	7:54	9:54	43.3

Sesfontein	4-Nov-2011	S5-21	24.0	N	0-5	7:25	9:25	33.0
Sesfontein	4-Nov-2011	S6	27.0	S/SE	0-5	7:08	9:08	34.0
Sesfontein	5-Nov-2011	S7	25.0	None	0	7:20	9:20	37.0
Sesfontein	5-Nov-2011	S8-27	25.0	W	0-5	7:15	9:15	37.0
Omatendeka	15-Nov-2011	O1	NA	None	0	8:00	10:00	NA
Omatendeka	17-Nov-2011	O2	30.5	None	0	8:20	10:20	43.6
Omatendeka	17-Nov-2011	O3	25.0	None	0	7:56	9:56	40.0
Omatendeka	18-Nov-2011	O4-20	30.1	NW	0-5	8:37	10:37	34.5
Ehirovipuka	19-Nov-2011	E1	26.1	None	0	7:27	9:27	41.7
Ehirovipuka	19-Nov-2011	E3	26.1	None	0	7:30	9:30	41.7
Torra	5-Mar-2012	T10	20.0	S	0-5	7:54	9:54	24.0
Torra	6-Mar-2012	T4-19	20.0	SE	0-5	7:51	9:51	25.0
Torra	8-Mar-2012	T8-28	21.0	SE	0-5	7:50	9:50	25.0
Torra	9-Mar-2012	T12	24.0	W	0-5	8:59	10:59	35.0
Torra	9-Mar-2012	T9-1	21.0	None	0	8:04	10:04	24.0
Torra	10-Mar-2012	T13	24.0	E	0-5	7:50	9:50	34.0
Torra	10-Mar-2012	T11	23.0	N	0-5	7:34	9:34	29.0
Torra	12-Mar-2012	T1-4	26.0	None	0-5	8:00	10:00	31.0
Torra	13-Mar-2012	T2-8	22.0	SW	0-5	8:07	10:07	30.0
Anabeb	19-Mar-2012	A4b	30.0	S	0-5	8:44	10:44	37.0
Anabeb	20-Mar-2012	A3	26.0	S	0-5	8:26	10:26	41.0
Sesfontein	24-Mar-2012	S8-27	28.0	SE	0-5	7:39	9:39	38.0
Sesfontein	25-Mar-2012	S3-12	25.0	S	0-5	7:50	9:50	28.0
Sesfontein	25-Mar-2012	S9	26.0	W	0-5	8:11	10:11	33.0
Sesfontein	26-Mar-2012	S5-21	26.0	NA	0-5	7:54	9:54	29.0
Sesfontein	26-Mar-2012	S10	25.0	NA	0-5	7:31	9:31	34.0
Sesfontein	27-Mar-2012	S7	21.0	NA	0-5	7:55	9:55	25.0
Ehirovipuka	7-Apr-2012	E4-39	22.0	W	0-5	8:25	10:25	32.0
Ehirovipuka	9-Apr-2012	E6	20.0	SW	0-5	8:20	10:20	32.0
Ehirovipuka	9-Apr-2012	E5	23.0	NA	0-5	7:53	9:53	37.0
Omatendeka	11-Apr-2012	O5	25.0	E	0-5	7:50	9:50	38.0
Omatendeka	12-Apr-2012	O6	33.0	N	0-5	8:40	10:40	35.0
Omatendeka	14-Apr-2012	O4-20	26.0	NW	5-10	8:31	10:31	38.0
Anabeb	19-Apr-2012	A3	28.0	SE	0-5	7:45	9:45	28.0
Anabeb	20-Apr-2012	A4	30.0	S	0-5	8:42	10:42	37.0
Torra	4-Oct-2012	T1-4	24.0	E	0-5	7:55	9:55	28.0
Torra	5-Oct-2012	T2-8	16.0	W	0-5	8:10	10:10	21.0
Torra	6-Oct-2012	T10	19.0	NA	0	8:01	10:01	26.0

Torra	7-Oct-2012	T4-19	14.0	N	5-10	7:42	9:42	22.0
Torra	8-Oct-2012	T8-28	20.0	NA	0-5	8:00	10:00	27.0
Torra	9-Oct-2012	T9-1	23.5	E	0-5	8:20	10:20	25.0
Anabeb	13-Oct-2012	A3	20.0	N	0-5	7:50	9:50	24.0
Anabeb	14-Oct-2012	A5	24.0	E	0-5	7:54	9:54	36.0
Sesfontein	15-Oct-2012	S3-12	24.0	NE	0-5	8:07	10:07	38.0
Sesfontein	16-Oct-2012	S8-27	18.0	None	0	7:25	9:25	23.0
Sesfontein	16-Oct-2012	S8-27	18.0	None	0	7:25	9:25	23.0
Sesfontein	17-Oct-2012	S6	23.0	E	0-5	7:46	9:46	37.0
Sesfontein	17-Oct-2012	S5-21	18.0	S	0-5	8:05	10:05	23.0
Sesfontein	19-Oct-2012	S2-7	24.0	E	0-5	8:35	10:35	32.0
Ehirovipuka	25-Oct-2012	E4-39	22.0	S	0-5	8:54	10:54	25.0
Omatendeka	29-Oct-2012	O1	27.0	N	0-5	7:53	9:53	33.0
Omatendeka	31-Oct-2012	O4-20	28.0	S	0-5	9:07	11:07	33.0
Palmwag	11-Nov-2012	P4	27.0	E	0-5	8:27	10:27	37.0
Palmwag	12-Nov-2012	P5	24.0	S	5-10	8:03	10:03	33.0
Palmwag	16-Nov-2012	P3	24.0	S	0-5	8:41	10:41	28.0
Palmwag	16-Nov-2012	P2	24.0	S	0-5	8:32	10:32	28.0
Palmwag	28-Nov-2012	P1	28.0	E	5-10	8:07	10:07	33.0
Torra	1-Mar-2013	T2-8	21.0	SE	5	8:02	10:02	29.0
Torra	4-Mar-2013	T8-28	27.0	NE	5	8:00	10:00	30.0
Torra	5-Mar-2013	T1-4	27.0	N	10	8:05	10:05	35.0
Torra	9-Mar-2013	T9-1	20.0	NW	5	8:24	10:24	33.0
Anabeb	15-Mar-2013	A5	25.0	NW	5	7:29	9:29	32.0
Anabeb	15-Mar-2013	A3	17.0	NW	5	7:18	9:18	36.0
Sesfontein	18-Mar-2013	S2-7	18.0	NE	0-5	7:45	9:45	25.0
Sesfontein	19-Mar-2013	S8-27	23.0	SW	0-5	7:28	9:29	34.0
Sesfontein	20-Mar-2013	S3-12	25.0	SE	0-5	7:19	9:19	29.0
Sesfontein	20-Mar-2013	S4-17	28.0	N	0-5	7:50	9:10	35.0
Ehirovipuka	27-Mar-2013	E4-39	21.0	W	0-5	8:15	10:15	26.0
Ehirovipuka	28-Mar-2013	E56	18.0	NE	0-5	7:39	9:39	25.0
Omatendeka	3-Apr-2013	O57	24.0	S	0-5	8:50	10:50	30.0
Torra	16-Apr-2013	T4-19	23.0	NE	5-10	7:45	9:45	31.0
Palmwag	18-Apr-2013	P1	21.0	E	0-5	7:15	9:15	25.0
Torra	5-Oct-2013	T1-4	14.0	SW	1	7:47	9:47	20.0
Torra	5-Oct-2013	T2-8	25.0	W	5	7:55	9:55	24.0
Torra	7-Oct-2013	T-10	24.0	E	20-25	8:07	10:07	30.0
Torra	8-Oct-2013	T8-28	16.0	E	5	7:57	9:57	22.0

Torra	8-Oct-2013	T9-1	27.0	E	5	7:58	9:58	33.0
Torra	10-Oct-2013	T4-19	27.0	E	0-5	7:50	9:50	25.0
Anabeb	18-Oct-2013	A5	21.0	E	0-5	7:45	9:45	36.0
Anabeb	18-Oct-2013	A3	22.0	NE	0-5	7:56	9:56	34.0
Sesfontein	20-Oct-2013	S3-12	16.0	SW	0-5	7:44	9:44	25.0
Sesfontein	20-Oct-2013	S4-17	15.0	SW	0-5	7:54	9:54	26.0
Sesfontein	21-Oct-2013	S1	10.0	SW	5-10	7:35	9:35	20.0
Sesfontein	22-Oct-2013	S8-27	17.0	N/A	0	7:25	9:25	25.0
Sesfontein	22-Oct-2013	S6	10.0	N/A	0	7:40	9:40	19.0
Sesfontein	24-Oct-2013	S2-7	10.0	SW	0-5	7:32	9:32	25.0
Ehirovipuka	4-Nov-2013	E5-6	15.0	N/A	0	7:43	9:43	32.0
Ehirovipuka	4-Nov-2013	E5	23.0		0-5	8:34	10:34	34.0
Palmwag	10-Nov-2013	P1	17.0	SW	0-5	7:28	9:28	24.0
Omatendeka	19-Nov-2013	O1	24.0	NE	0-5	7:54	9:54	35.0
Omatendeka	21-Nov-2013	O4-20	24.0	SW	0-5	8:46	10:46	29.0
Torra	11-Mar-2014	T2-8	18.0	W	0-5	7:55	9:55	20.0
Torra	11-Mar-2014	T14	16.0	SW	0-5	7:53	9:53	26.0
Torra	13-Mar-2014	T10	20.0	E	0-5	7:57	9:57	23.0
Torra	14-Mar-2014	T9-1	22.0	W	0-5	7:49	9:49	25.0
Torra	14-Mar-2014	T8-28	21.0	W	0-5	7:36	9:36	24.0
Torra	16-Mar-2014	T4-19	24.0	E	5-10	7:53	9:53	27.0
Anabeb	23-Mar-2014	A6	24.0	E	5-10	8:04	10:04	29.0
Anabeb	23-Mar-2014	A3	24.0	E	0-5	8:03	10:03	29.0
Sesfontein	25-Mar-2014	S3-12	19.0	W	0-5	7:35	9:35	26.0
Sesfontein	25-Mar-2014	S4-17	26.0	W	0-5	8:02	10:02	35.0
Sesfontein	26-Mar-2014	S1b	19.0	E	0-5	7:55	9:55	23.0
Sesfontein	27-Mar-2014	S6	24.0	E	0-5	7:43	9:43	30.0
Sesfontein	27-Mar-2014	S8-27	22.0	N	0-5	7:33	9:33	31.0
Sesfontein	29-Mar-2014	S2-7	23.0	SW	0-5	7:26	9:26	31.0
Palmwag	15-Apr-2014	P1	22.0	E	5-10	7:55	9:55	35.0
Ehirovipuka	25-Apr-2014	E5	19.0	W	0-5	7:31	9:33	23.0
Ehirovipuka	25-Apr-2014	E5-6	19.0	E	0-5	7:45	9:45	32.0
Omatendeka	25-Apr-2014	O1	23.0	N	5-10	7:40	9:40	40.0
Omatendeka	1-May-14	O4-20	26.0	E	0-5	8:16	10:16	30.0

[1]Wind information at time of sampling; provided for future planning to avoid disturbing animals as approach site on foot

Table II-4. Summary of point count survey results for surveys completed in 5 Conservancies and Palmwag Concession in the Kunene region of northern Namibia between October 2011 and April 2014; information includes total counts and sighting rates listed as total count/sighting rate; hours of survey effort are listed after each Conservancy name.

Species	Latin Name	Anabeb (28 hrs.)	Ehirovipuka (26 hrs.)	Omatendeka (28 hrs.)	Palmwag (16 hrs.)	Sesfontein (70 hrs.)	Torra (82 hrs.)
Black-backed jackal	*Canis mesomelas*	1/0.04	0	0	0	0	0
Black mongoose	*Galerella nigrata*	0	0	0	1/0.06	0	0
Black rhino	*Diceros bicornis*	0	0	0	0	0	15/0.18
Black-faced impala	*Aepyceros melampus petersi*	0	10/0.38	0	0	0	0
Brown hyena	*Hyaena brunnea*	0	0	0	0	0	1/0.01
Chacma baboon	*Papio ursinus*	0	10/0.38	13/0.46	0	4/0.06	26/0.32
Cheetah	*Acinonyx jubatus*	0	0	0	0	0	3/0.04
Eland	*Taurotragus oryx*	0	73/2.81	15/0.54	0	0	0
Gemsbok	*Oryx gazella*	18/0.64	59/2.23	95/3.39	35/2.18	86/1.23	599/7.30
Giraffe	*Giraffa camelopardalis*	6/0.21	61/2.35	37/1.32	0	14/0.30	33/0.40
HM Zebra	*Equus Zebra hartmannae*	776/27.7	340/13.1	221/7.89	517/32.3	266/3.80	1062/13.0
Klipspringer	*Oreotragus oreotragus*	0	0	2/0.07	0	0	0
Kudu	*Tragelaphus strepsicerus*	12/0.43	7/0.27	20/0.71	0	1/0.01	82/1.0
Lion	*Panthera leo*	0	0	0	1/0.06	0	0
Ostrich	*Struthio camelus*	25/0.89	20/0.77	0	7/0.44	120/1.71	47/0.57
Rock hyrax	*Procavia capensis*	0	0	0	0	3/0.04	0
Spotted hyena	*Crocuta crocuta*	0	0	0	2/0.13	0	6/0.07
Springbok	*Antidorcas marsupialis*	173/6.18	260/10.0	204/7.29	343/21.4	637/9.10	305/3.72
Steenbok	*Raphicerus campestris*	0	1/0.04	0	0	5/0.07	2/0.02

[1] Sighting rate is the total count/total observation hours in each Conservancy

Table III-5. Total counts of species observed on point count surveys during Oct-Nov 2013. Information includes total counts and sighting rates listed as total count/sighting rate in each Conservancy; hours of survey effort are listed after each Conservancy.

		Conservancy/Concession (time at point count locations (hr))					
Common Name	**Latin Name**	**Anabeb (4 hrs)**	**Ehirovipuka (4 hrs)**	**Omatendeka (4 hrs)**	**Palmwag (2 hrs)**	**Sesfontein (12 hrs)**	**Torra (12 hrs)**
Brown hyena	*Hyaena brunnea*	0	0	0	0	0	1/0.08
Chacma baboon	*Papio ursinus*	10/2.5	13/3.25	0	0	0	6/0.5
Eland	*Taurotragus oryx*	0	8/2.0	1/0.25	0	0	0
Gemsbok	*Oryx gazella*	0	2/0.5	9/2.25	0	7/0.58	105/8.75
Giraffe	*Giraffa camelopardalis*	2/0.5	7/1.75	7/1.75	0	0	13/1.08
HM Zebra	*Equus Zebra hartmannae*	1/0.25	28/7.0	4/1.0	12/6.0	51/4.25	146/12.2
Kudu	*Tragelaphus strepsicerus*	0	0	4/1.0	0	0	9/0.75
Ostrich	*Struthio camelus*	0	0	0	0	11/0.08	9/0.75
Springbok	*Antidorcas marsupialis*	20/5.0	6/1.5	37/9.25	0	14/1.17	70/5.83
Steenbok	*Raphicerus campestris*	0	1/0.25	0	0	3/0.25	2/0.17

Table III-6. Total counts of species observed on point count surveys during Mar-Apr 2014. Information includes total counts and sighting rates listed as total count/sighting rate in each Conservancy; hours of survey effort are listed after each Conservancy.

		Conservancy/Concession (time at point count locations (hr))					
Common Name	**Latin Name**	**Anabeb (4 hrs)**	**Ehirovipuka (4 hrs)**	**Omatendeka (4 hrs)**	**Palmwag (2 hrs)**	**Sesfontein (12 hrs)**	**Torra (12 hrs)**
Chacma baboon	*Papio ursinus*	0	0	0	0	4/0/25	0
Eland	*Taurotragus oryx*	0	56/14.0	11/2.75	0	0	0
Gemsbok	*Oryx gazella*	1/0.25	0	36/9.0	1/0.5	8/0.67	121/10.1
Giraffe	*Giraffa camelopardalis*	0	23/5.75	3/0.75	0	0	2/0.17
HM Zebra	*Equus Zebra hartmannae*	181/45.3	25/6.25	18/4.5	26/13.0	151/12.6	88/7.3
Klipspringer	*Oreotragus oreotragus*	0	0	2/0.5	0	0	0
Kudu	*Tragelaphus strepsicerus*	0	0	6/1.5	0	0	7/0.58
Ostrich	*Struthio camelus*	11/2.75	0	0	0	44/3.67	9/0.75
Spotted hyena	*Crocuta crocuta*	0	0	0	0	0	3/0.25
Springbok	*Antidorcas marsupialis*	2/0.5	0	30/7.5	0	104/8.67	44/3.67

APPENDIX IV: FIELD EFFORT AND DATA SUMMARY OF REMOTE CAMERA SURVEYS

This Appendix summarizes the data collected using remote cameras across 6 seasons of surveys (Oct-Nov 2011, Mar-Apr 2012, Oct-Nov 2012, Mar-Apr 2013, Oct-Nov 2013, Mar-Apr 2014).

Summary of Effort. Infra-red remote triggered cameras were placed at Collin's Spring (178 trap days), Jebico Spring (230 trap days) and Zebra Spring (11 trap days) in Torra and two locations within the Concession: a remote location nearby Wereldsend camp (7 trap days) and Wereldsend Spring (167 trap days) for a total of 593 trap days (Table IV-1). In Oct-Nov 2013 and Mar-Apr 2014, we established 3 camera sites which ran for a total of 107 and 108 days each season respectively in the Palmwag Concession and in Torra Conservancy (Table IV-2.

Summary of Data. Fourteen nocturnal or elusive species were photographed at the remote camera trap stations. Leopards were identified at Collin's Spring, Jebico Spring, and Wereldsend Spring. Lions were photographed at Jebico Spring and Wereldsend Spring. Brown hyenas were photographed at Collin's Spring and Jebico Spring. The camera station at Jebico Spring appeared to have the highest diversity of elusive species (Table IV-3).

In Oct-Nov 2013 and Mar-Apr 2014, we observed 8 and 6 wildlife species respectively using remote camera surveys (Table IV-4). In both seasons, a brown hyena made an appearance at two camera trap sites.

Table 21. Camera trap photographs of species identified at three sites in Torra Conservancy and Palmwag Concession for Oct-Nov 2013 and Mar-Apr 2014 sampling periods. Photographs of elusive species and predators were counted when a period of 30 minutes had passed without a photo being taken. Numbers are not indicative of number of unique individuals as the same animals could visit the camera station multiple times.

		Oct-Nov 2013			Mar-Apr 2014		
Identified Species	**Scientific Name**	**Collin's**	**Jebico**	**Werelds-end**	**Collin's**	**Jebico**	**Werelds-end**
African wildcat	*Felis libyca*		1				
Black-backed Jackal	*Canis mesomelas*		7	6		1	33
Black mongoose	*Galerella nigrata*	4	13				
Brown Hyena	*Hyaena brunnea*	1	1		1	1	
Elephant	*Loxodonta africana*						16
Greater Genet	*Genetta genetta*		1				
Honey Badger	*Mellivora capensis*		1				
Leopard	*Panthera pardis*	5	1				
Lion	*Panthera leo*					1	8
Porcupine	*Hystrix cristata*						3
Spotted Hyena	*Crocuta crocuta*	6	5			6	4

Table IV-1. Camera trap locations and field effort in Torra Conservancy and Palmwag Concession from November 2011 to April 2014.

Conservancy/ Concession	Site Name	Camera trap days	Photos reviewed
Palmwag	Wereldsend Spring	167	18,636
Palmwag	Wereldsend 2	7	449
Torra	Collin's Spring	178	24,990
Torra	Jebico Spring	230	12,053
Torra	Zebra Spring	11	18
TOTAL		**593**	**56,146**

Table IV-2. Camera trap locations and field effort in Torra Conservancy and Palmwag Concession during Oct-Nov 2013 and Mar-Apr 2014.

		Oct-Nov 2013		Mar-Apr 2014	
Conservancy/ Concession	Site Name	Camera trap days	Photos reviewed	Camera trap days	Photos reviewed
Palmwag	Wereldsend	20	507	37	9170
Torra	Collin's	23	372	41	8820
Torra	Jebico	64	3659	30	721
TOTAL		**107**	**4538**	**108**	**18,711**

Table IV-3. Camera trap photographs of species identified at five sites in Torra Conservancy and Palmwag Concession. Photographs of elusive species and predators were counted when a period of 30 minutes had passed without a photo being taken. Numbers are not indicative of number of unique individuals as the same animals could visit the camera station multiple times.

Identified Species	**Scientific Name**	**Collin's Spring**	**Jebico Spring**	**Zebra Spring**	**Wereldsend Spring**	**Wereldsend 2**	**TOTAL**
African wildcat	*Felis libyca*	1	2				3
Black-backed Jackal	*Canis mesomelas*		17	1	104	1	123
Black mongoose	*Galerella nigrata*	4	13				17
Brown Hyena	*Hyaena brunnea*	7	5				12
Cape Fox	*Vulpes chama*		1				**1**
Caracal	*Felis caracal*		1				1
Elephant	*Loxodonta africana*	3			16		19
Greater Genet	*Genetta genetta*		1				1
Honey Badger	*Mellivora capensis*		2		1		3
Leopard	*Panthera pardis*	8	14		4		26
Lion	*Panthera leo*		2		9		11
Porcupine	*Hystrix cristata*		16		10		26
Slender Mongoose	*Galerella sanguine*		14				14
Spotted Hyena	*Crocuta crocuta*	6	25	2	9		42
TOTAL		**29**	**113**	**3**	**153**	**1**	**299**

Table IV-4. Camera trap photographs of species identified at three sites in Torra Conservancy and Palmwag Concession. Photographs of elusive species and predators were counted when a period of 30 minutes had passed without a photo being taken. Numbers are not indicative of number of unique individuals as the same animals could visit the camera station multiple times.

		Oct-Nov 2013			Mar-Apr 2014		
Identified Species	**Scientific Name**	**Collin's**	**Jebico**	**Wereldsend**	**Collin's**	**Jebico**	**Wereldsend**
African wildcat	*Felis libyca*		1				
Black-backed Jackal	*Canis mesomelas*		7	6		1	33
Black mongoose	*Galerella nigrata*	4	13				
Brown Hyena	*Hyaena brunnea*	1	1		1	1	
Elephant	*Loxodonta africana*						16
Greater Genet	*Genetta genetta*		1				
Honey Badger	*Mellivora capensis*		1				
Leopard	*Panthera pardis*	5	1				
Lion	*Panthera leo*					1	8
Porcupine	*Hystrix cristata*						3
Spotted Hyena	*Crocuta crocuta*	6	5			6	4