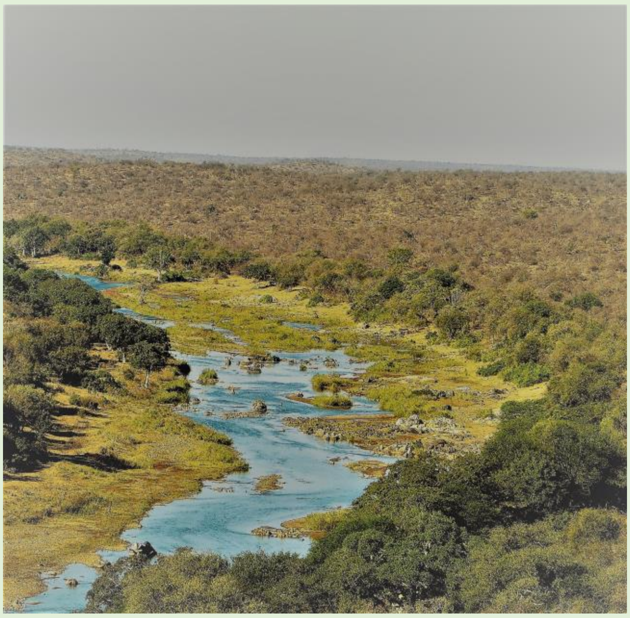
Ecological Monitoring:

Association of Private Nature Reserves

(Timbavati, Umbabat, Klaserie, Balule and Thornybush)



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Fifteenth Joint Report: 2017

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The ARC-API project team working on the APNR included:

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EXPANDED SUMMARY

This report is the fifteenth joint “annual ecological audit” for the landowners of the APNR (Association of Private Nature Reserves). This year we include Thornybush Nature Reserve (TNR) as a member of the APNR annual report. TNR brings an excellent ecological record to the table. The general background to the study, methods used, and initial results and discussion can be obtained from the reports dating back to 1990 and reserves making up the APNR have been a part of this ecological programme since its inception in 1989/90 (see reference list in this document).

To recap, the objective of the monitoring programme is to ascertain the current situation and trends in the resources of the Lowveld (some 450 000ha). This includes the measurement and description of plant species composition and structure, and the quantification of the relations between various aspects of the vegetation, management practices (e.g. stocking rates, fire and bush clearing), soils, rainfall, other climatic variables, the woody/herbaceous ratio and the faecal analysis programme. This report is presented as an expanded summary.

As discussed in the previous report, the process of Adaptive Planning as laid down by the Department of Environmental Affairs and Tourism for setting norms and standards for National Protected Area has been integrated into a comprehensive management plan for the APNR. Besides the legal requirements in terms of the National Environment Management: Protected Areas Act No. 57 of 2003 (NEM: PAA), such a Management Plan serves several important purposes.

This includes the following:

1. It adds value to the reserve and its individual constituent properties as an integrated concept with clearly defined objectives and approaches. This guarantees continuity;
2. A well-articulated plan assists with obtaining the necessary permits and authorisations from the relevant Nature Conservation and Environmental authorities;
3. The Management Plan assists in the yearly planning (and budgeting) of veld management tasks.

The **APNR** Management Plan was completed in 2009 and edited in 2016. However as the

APNR is not a constituted body the combined APNR plan had no legal standing. We have thus embarked on an initiative to prepare individual management plans for the Klaserie (first draft complete), Timbavati (first draft complete, Balule (*in prep.*), Umbabat (*in prep.*) and Thornybush (*in prep.*). The individual plans will be in line with the plans for all of the conservation areas forming the Greater Limpopo Transfrontier Conservation Area (GLTFCA). We have completed Management Plans for the Kapama Game Reserve, Fleur de Lys Game Reserve, Blue Canyon Game Conservancy, Sabi Sand Wildtuin, MalaMala Game Reserve, joint SSW-MalaMala plan, Eden Nature Reserve (Nelspruit), Penryn College (Nelspruit/White River), Hans Merensky Estate (Phalaborwa), Raptors View, Thornybush Game Reserve, and Longmere (Ridgemere) Estate and these are lodged with the Limpopo Department of Economic Development Environment and Tourism (LEDET) and the Mpumalanga Parks and Tourism Authority (MTPA). The latter plans will, in time be brought in line with the GLTFCA plans.

I refer to three other significant reports for the APNR: “GRAZING SITUATION AND OFFTAKES 2016: APNR FOR CONSIDERATION: CHAIRMEN AND WARDENS APNR (v8) - 12/04/16 – to Klaserie, Balule, Umbabat and Timbavati Representatives” (kept in for completeness this year as we experience the effects of the extended drought); and “MANAGING HERBIVORE BIOMASS IN THE ASSOCIATION OF PRIVATE NATURE RESERVES (APNR): WITH SPECIAL REFERENCE TO ELEPHANT (*LOXODONTA AFRICANA*)” - Dr Mike Peel & Dr Jeremy Anderson May 2016 (Final September 2016$_{v5}$). The latter was circulated to 28 external reviewers and the authors in turn answered all respondents. The report proved to be a large undertaking that yielded lively and challenging debate, and four versions were drafted before the final fifth version was presented to Mr Mike Anderson. Mr. Anderson is thanked by the authors for the even-handed manner in which he dealt with this highly contentious issue. The offtakes correspondence can be found in “APNR Offtake Assessment – Appendix D” (under discussion until February 2018).

RAINFALL

The importance of extreme rainfall seasons (particularly very dry or very wet), are important in driving these systems. Note that with the changes in weather/climate patterns that are predicted (and indeed appear to be happening) the prediction is that rainfall in these semi-arid savannas will become less predictable and more variable. It could be that we are going to experience greater variability and extremes in rainfall with ‘wetter wet seasons’ and ‘drier dry seasons’. Current modeling efforts hint at increased variability in annual rainfall in this area that further puts a premium on good grass/herb cover to avoid increased runoff and erosion.

The observed effect of rainfall on the vegetation is discussed under the vegetation section of this report. The importance of careful management is emphasised as this allows for hazards (normally drought related-current) to be avoided and opportunities (following favourable seasons) to be grasped. A drought is defined as being a rainfall season in which less than 75% of the mean annual rainfall is received. From the latter, it can be said that: KPNR suffered drought conditions in 2014/15 and 2015/16 (severe) and a dry 2016/17; UPNR suffered drought conditions in 2014/15 and 2015/16 followed by a wet 2016/17; TPNR suffered dry conditions in 2014/15, drought conditions in 2015/16 and a dry 2016/17; BNR suffered dry conditions in 2014/15, drought in 2015/16 and a dry 2016/17; TNR suffered drought conditions in 2014/15 and 2015/16 and a close to expected 2016/17 (Table 1 and Figure 1a). The six years prior to that were favourable in the APNR as a whole, dominated by close to mean and wet years (2011/12 to 2013/14 very wet) (Figure 1a and Figure 1b) and this has had an important lag effect on the current condition of the APNR rangelands (see vegetation section).

Table 1 - Summary of annual rainfall for the APNR.

Year	KPNR Mn 38y 441mm*	% of mean	Comment	UPNR Mn 35y 435mm*	% of mean	Comment	TPNR Mn 38y 528mm*	% of mean	Comment	BNR Mn 31y 447mm*	% of mean	Comment	TNR Mn 24y 645mm*	% of mean	Comment
1979/80	561	127	Very Wet				658	125	Wet						
80/81	816	185	Very wet				710	134	Very wet						
81/82	524	119	Wet				401	76	Dry						
82/83	182	41	Severe drought	229	53	Drought	340	64	Drought						
83/84	448	102	Close to mean	460	106	Wet	664	126	Very wet						
84/85	735	167	Very wet	813	187	Very wet	867	164	Very wet						
85/86	323	73	Drought	498	115	Wet	351	66	Drought	403	90	Dry			
86/87	293	66	Drought	272	63	Drought	524	99	Close to mean	357	80	Dry			
87/88	450	102	Close to mean	559	129	Very wet	551	104	Close to mean	441	99	Close to mean			
88/89	304	69	Drought	225	52	Drought	358	68	Drought	318	71	Drought			
89/90	435	99	Close to mean	439	101	Close to mean	512	97	Close to mean	443	99	Close to mean			
90/91	309	70	Drought	433	100	Close to mean	513	97	Close to mean	428	96	Dry			
91/92	258	59	Drought	166	38	Severe drought	263	50	Drought	164	37	Severe drought			
92/93	313	71	Drought	516	119	Wet	585	111	Wet	415	93	Dry			
93/94	304	69	Drought	233	54	Drought	406	77	Dry	356	80	Dry	420	65	Drought
94/95	372	84	Dry	495	114	Wet	350	66	Drought	437	98	Close to mean	437	68	Drought
95/96	632	143	Very wet	597	137	Very wet	873	165	Very wet	765	171	Very wet	1083	168	Very wet
96/97	383	87	Dry	357	82	Dry	511	97	Close to mean	229	51	Drought	709	110	Wet
97/98	253	57	Drought	269	62	Drought	361	68	Drought	235	53	Drought	487	75	Dry
98/99	670	152	Very wet	552	127	Very wet	718	136	Very wet	516	116	Wet	851	132	Very wet
99/00	880	200	Very wet	829	191	Very wet	1062	201	Very wet	741	166	Very wet	1087	169	Very wet
00/01	458	104	Close to mean	349	80	Dry	537	102	Close to mean	433	97	Close to mean	563	87	Dry
01/02	349	79	Dry	225	52	Drought	452	86	Dry	411	92	Dry	632	98	Close to mean
02/03	251	57	Drought	297	68	Drought	345	65	Drought	254	57	Drought	330	51	Drought
03/04	403	91	Dry	558	128	Very wet	583	110	Wet	452	101	Close to mean	501	78	Dry
04/05	274	62	Drought	363	83	Dry	377	71	Drought	330	74	Drought	463	72	Drought

Year	KPNR Mn 38y 441mm*	% of mean	Comment	UPNR Mn 35y 435mm*	% of mean	Comment	TPNR Mn 38y 528mm*	% of mean	Comment	BNR Mn 31y 447mm*	% of mean	Comment	TNR Mn 24y 645mm*	% of mean	Comment
05/06	594	135	Very wet	450	103	Close to mean	592	112	Wet	649	145	Very wet	783	121	Wet
06/07	370	84	Dry	395	91	Dry	443	84	Dry	364	81	Dry	474	74	Drought
07/08	367	83	Dry	343	79	Dry	384	73	Drought	391	88	Dry	446	69	Drought
08/09	446	101	Close to Mean	461	106	Wet	492	93	Dry	598	134	Very wet	703	109	Wet
09/10	414	94	Dry	439	101	Close to mean	451	85	Dry	597	134	Very wet	742	115	Wet
10/11	463	105	Close to Mean	491	113	Wet	578	109	Wet	456	102	Close to mean	675	105	Close to mean
11/12	871	198	Very wet	605	139	Very wet	686	130	Very wet	740	166	Very wet	923	143	Very wet
12/13	586	133	Very wet	620	143	Very wet	619	117	Wet	649	145	Very wet	876	136	Very wet
13/14	581	132	Very wet	619	142	Very wet	738	140	Very wet	665	149	Very wet	856	133	Very wet
14/15	302	69	Drought	292	67	Drought	460	87	Dry	337	76	Dry	466	71	Drought
15/16	212	48	Severe drought	283	65	Drought	281	53	Drought	309	69	Drought	324	50	Drought
16/17	358	81	Dry	488	112	Wet	487	92	Dry	409	92	Dry	649	101	Close to mean

* The mean is updated annually so the previous year’s percentage figures will vary slightly as the mean changes. As new stations are added, they are also included in the data set.

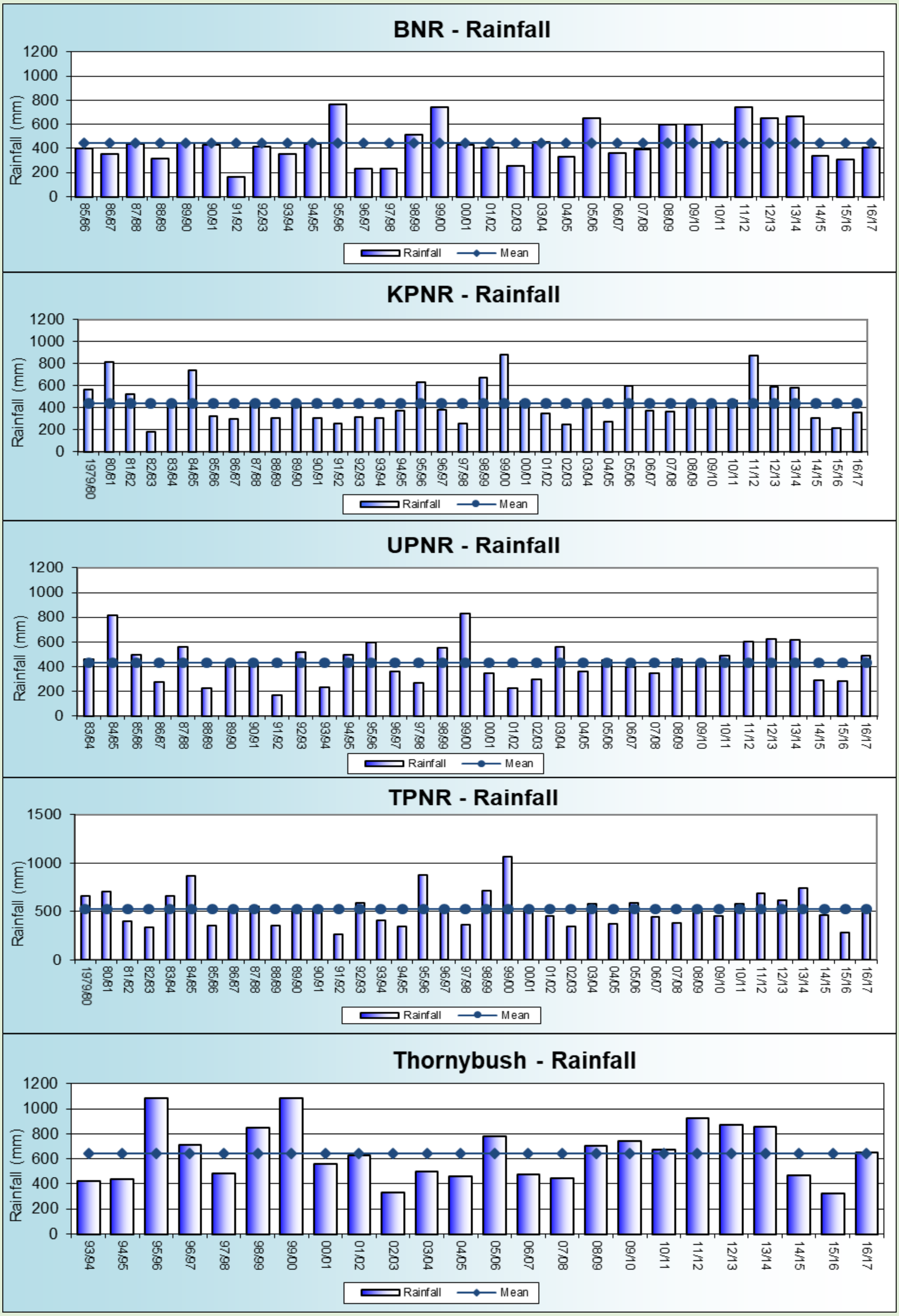

Figure 1 Annual rainfall for APNR and mean (from north to south).

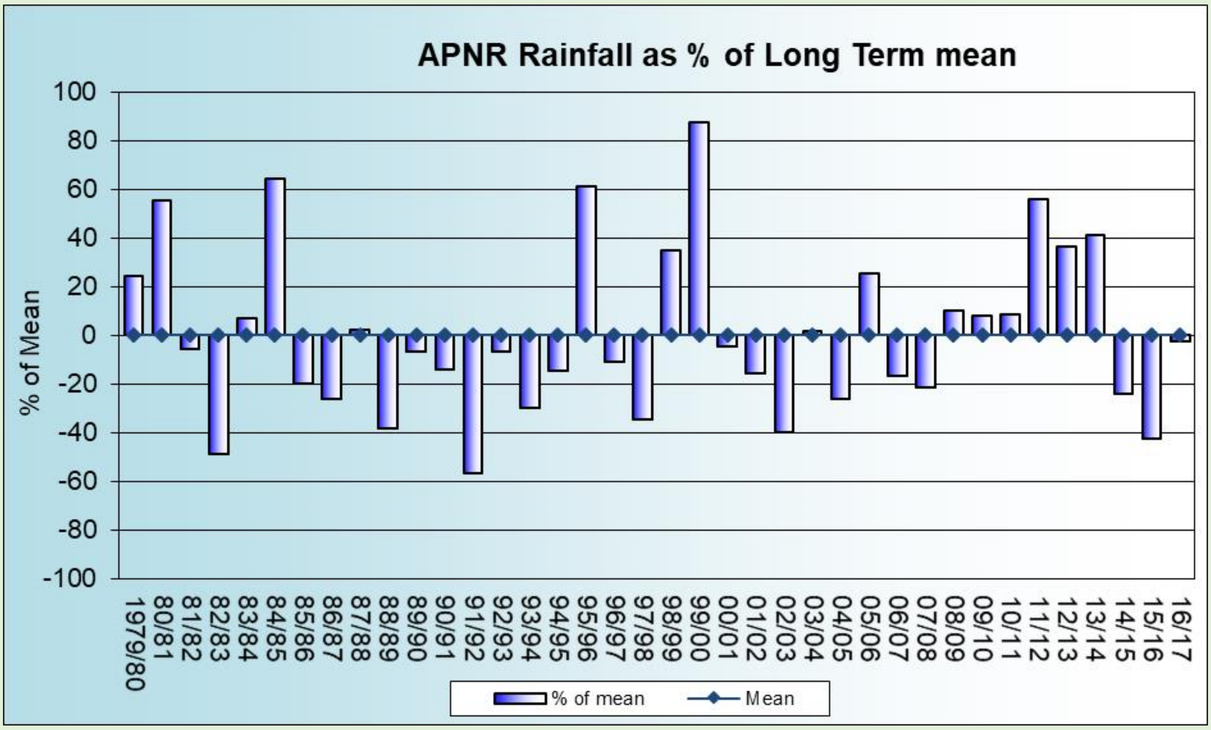

Figure 1a Annual rainfall as a percentage of the long-term mean for the APNR.

THE VEGETATION

The monitoring results are discussed and presented graphically in Figures 2 to 12 and in Tables 2 to 6. A discussion of the results follows in the text. Vegetation changes on APNR are thus tracked and a further strength of the monitoring programme is the capacity to also compare vegetation condition with other reserves in the area. We compare important vegetation parameters among APNR and three other reserves in the area.

Grass

Figures 2 to 4 illustrate the trends in important grass parameters. After large declines in 2015/16 and with a return to nearer normal rainfall conditions, the perennial component improved in KPNR, UPNR, TPNR (marked) and TNR (marginal increase but an already relatively high perennial component). The same trends were observed in the cover (distance) measures, the only concern once again was BNR where there was a decline (for a fifth year running). The cover (tuft size) varied from slight increases to relatively stable. Overall therefore the ‘wetter’ south (TPNR and TNR) has higher proportions of perennial grasses and a better cover than the drier north (BNR, KPNR and UPNR). The lower tuft sizes in the TNR are probably a function of higher stocking densities resulting in tufts that are smaller but close together. There is currently varying proportions of perennial grasses in the APNR from low (BNR), moderate-low (UPNR), moderate-high (TNR and KPNR) to high (TPNR).

The prevailing conditions suggest that the perennial composition and cover will in all probability improve in the APNR or at least be maintained (the degree depending on the 2017/18 season, which has been variable but tending to the dry end thus far). While driven by rainfall, an active hands-on adaptive management programme influences the degree to which rainfall modifies parameters such as the annual/perennial ratio and cover. This is particularly relevant in the light of the fact that the neighbouring Kruger National Park (KNP) closed artificial water points thus potentially precipitating an influx of animals into the areas adjacent to the KNP (NNB see Appendix A and B for further discussion in this regard as well as Peel & Anderson, 2016).

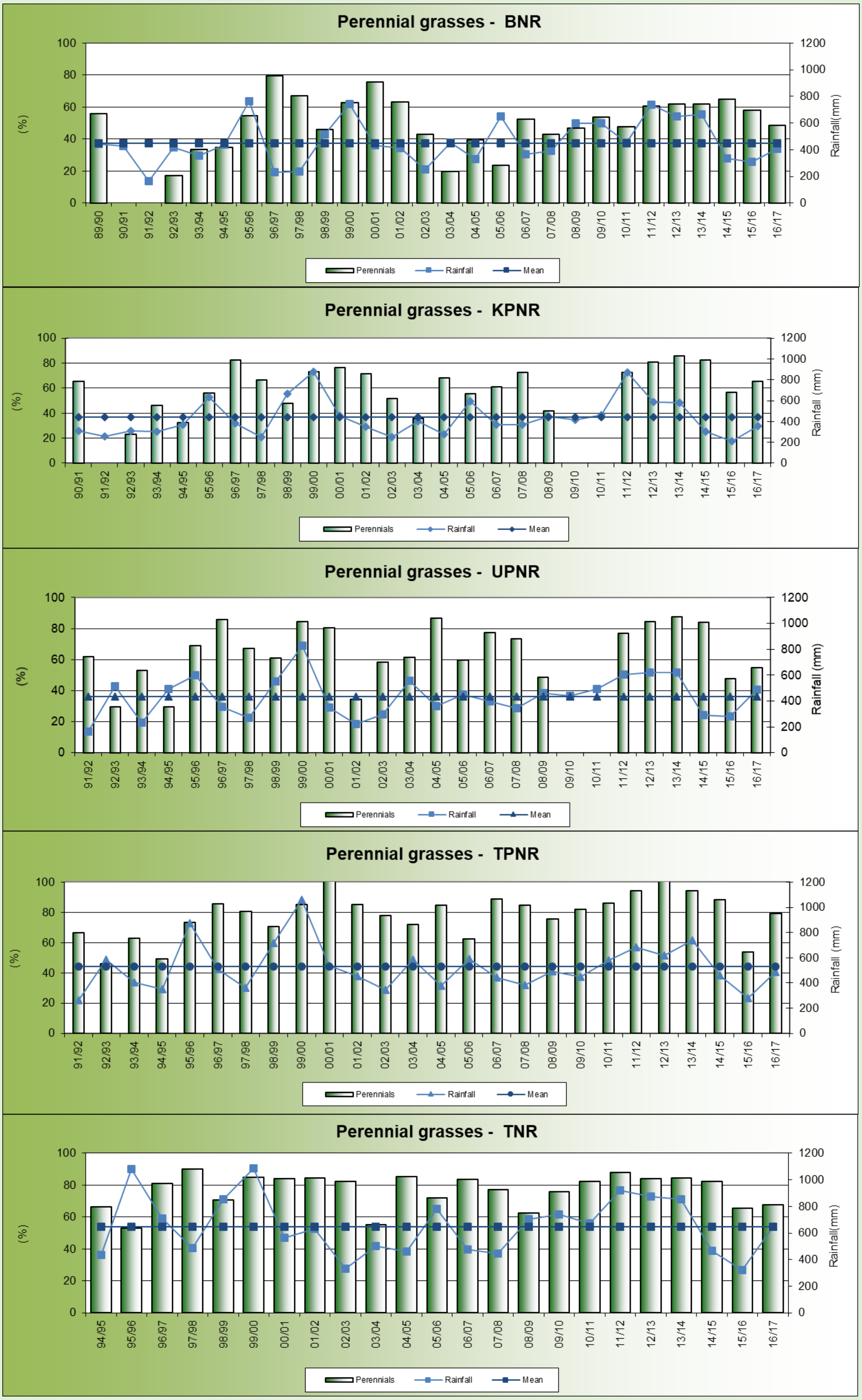

Figure 2 Percentage perennial grasses present on APNR and rainfall.

Table 2 Perennial grass composition trends within the APNR (refer Figure 2).

APNR overall	General Comment **2016/17**; and Comment **Long term**
	Increase – Moderate-high proportion of perennial grasses; **moderate-high**
BNR 26y	**Decline** – Low proportion of perennial grasses; **moderate-low**
KPNR 23y	**Increase** – Moderate-high proportion of perennial grasses; **moderate-high**
UPNR 24y	**Increase** – Moderate-low proportion of perennial grasses; **moderate-high**
TPNR 26y	**Marked increase** – High proportion of perennial grasses; **high**
TNR 23y	**Stable** – Moderate high; **high**

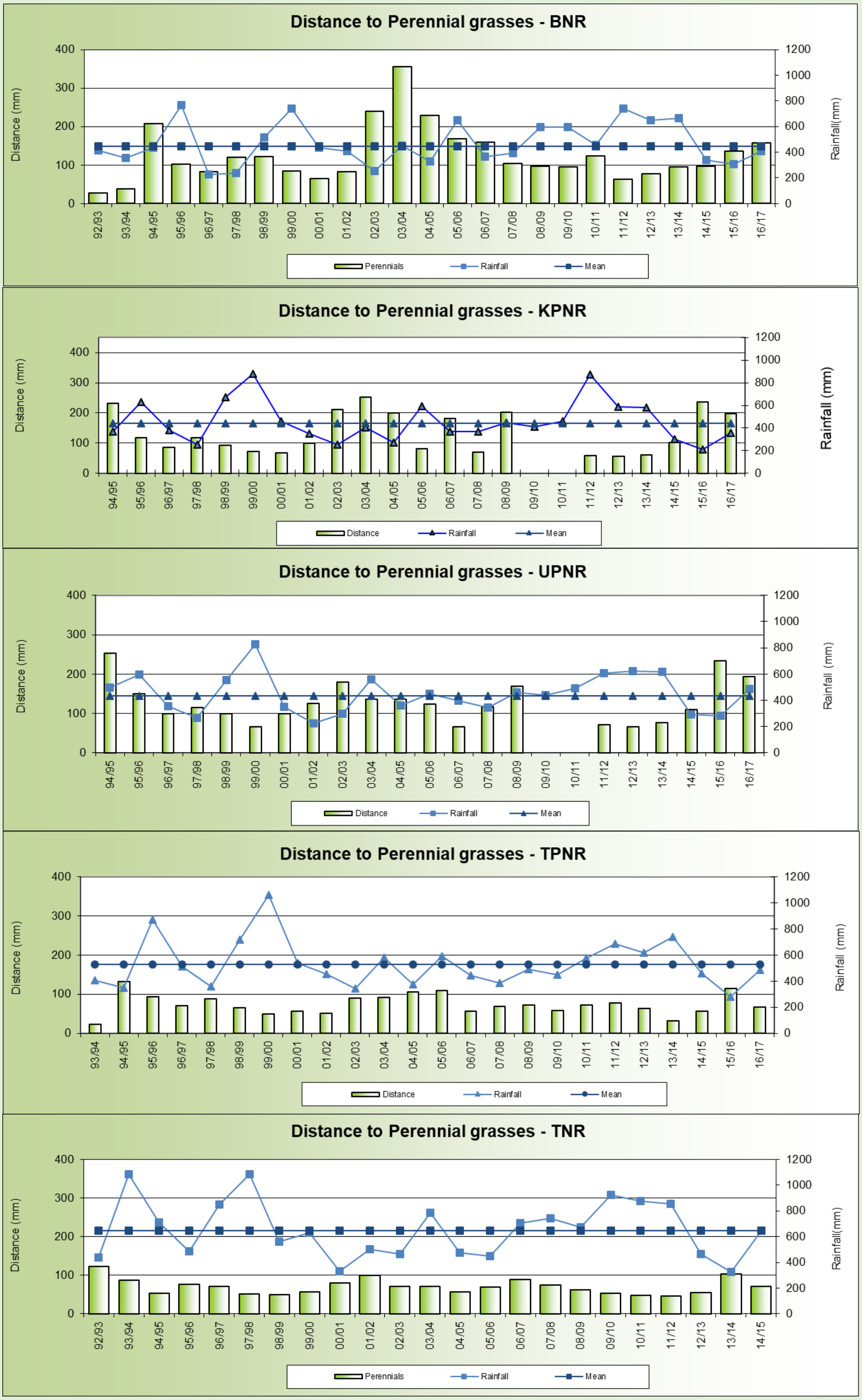

Figure 3 Mean distance to perennial grasses on APNR and rainfall.

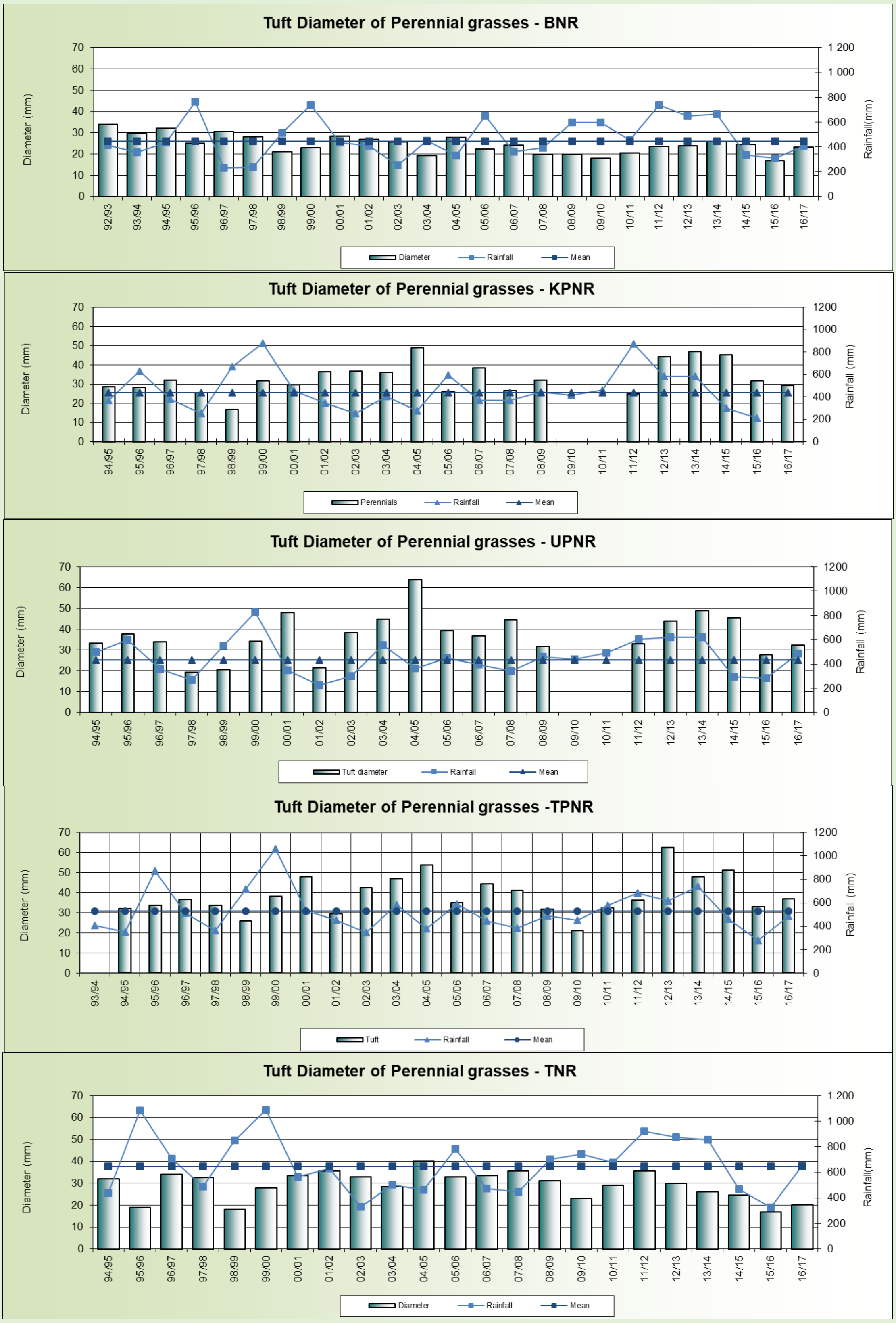

Figure 4 Mean tuft diameter of perennial grasses on APNR and rainfall.

Table 4 Perennial grass cover trends in the APNR (refer Figure 3 and Figure 4).

APNR overall	General Comment **2016/17**; and **Long term;** Distance measure (top), tuft measure (bottom)
	General improvement - Low; **Moderate-low** **General improvement – Moderate; Moderate**
BNR 25y	**Decline -** Low; Low **Increase –** Low; Low
KPNR 21y	**Improvement** – Low; Moderate **Stable –** Moderate; Moderate
UPNR 21y	**Improvement** – Low; Moderate **Decline –** Moderate; Moderate
TPNR 23y	**Marked improvement** – Moderate; Moderate **Improvement –** Moderate; Moderate
TNR 23y	**Marked improvement –** Moderate; Moderate **Stable** – Moderate; Moderate

Grass standing crop is a function of herbaceous production and represents the portion of production that remains after utilisation (Figure 5 and Table 5). The grass standing crop at the end of the 2016/17 - summer season was **low** for the APNR overall. For the individual reserves the following BNR (low); KPNR (very low); UPNR (very low); TPNR (low) and TNR (moderate-low).

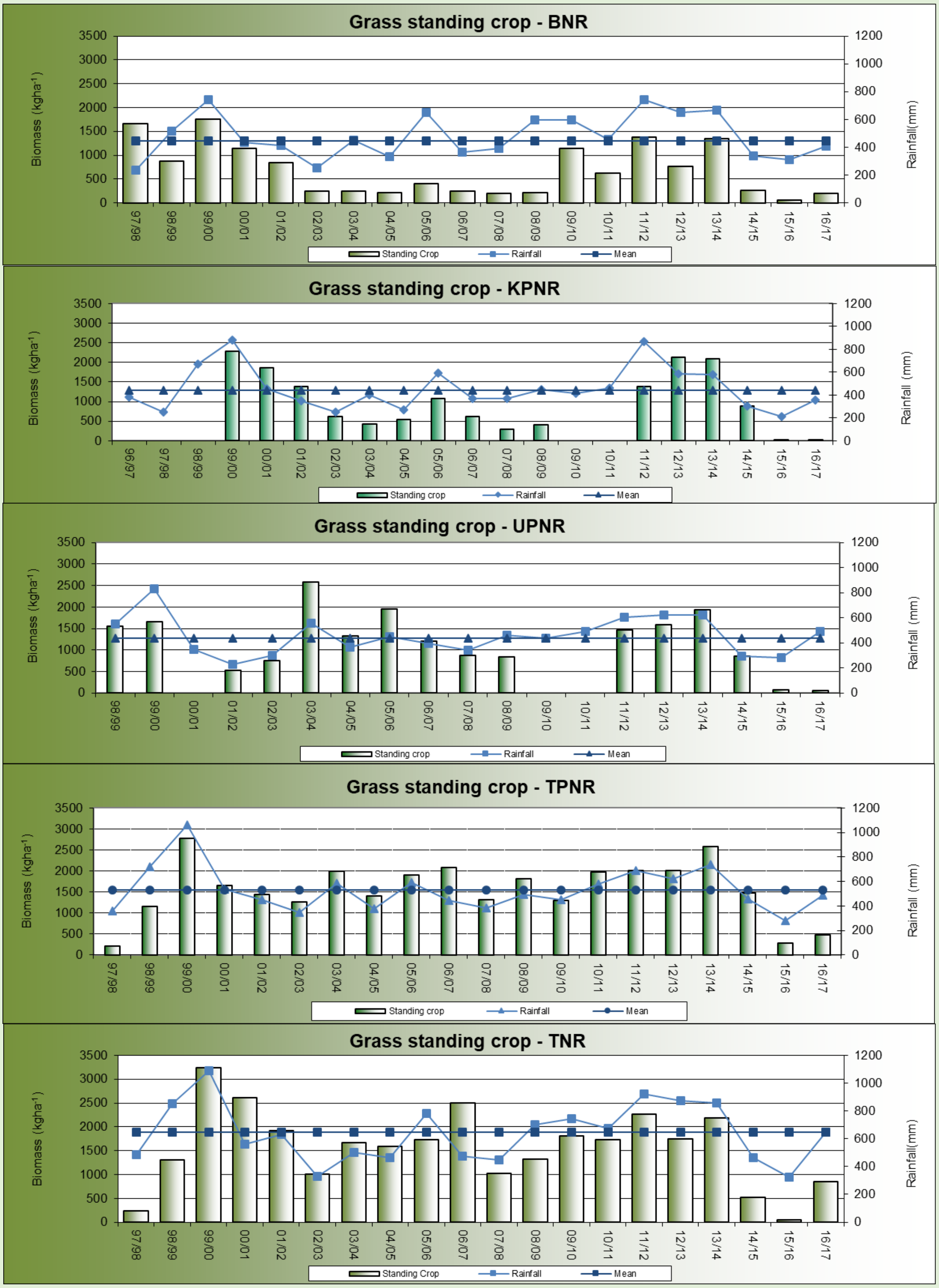

Figure 5 Grass standing crop on APNR and rainfall.

Table 5 Perennial grass standing crop trends in the APNR (refer Figure 5 and Figure 6).

Comment Long term	Trend VH=very high; H=high; MH=moderate high; M=moderate; ML=moderate low; L=low; VL=very low													
	04	05	06	07	08	09	10	11	12	13	14	15	16	17
APNR Overall	M	ML	M	M	ML	ML	M	M	MH	MH	MH	ML	VL	L
BNR	VL	VL	L	VL	VL	VL	M	ML	M	ML	M	VL	VL	L
KPNR	L	ML	M	ML	L	L			M	H	H	ML	VL	VL
UPNR	VH	M	MH	M	ML	ML			M	MH	H	ML	VL	VL
TPNR	MH	M	MH	H	M	MH	M	MH	H	MH	VH	M	L	L
TNR	MH	MH	MH	VH	M	M	MH	MH	H	MH	H	ML	VL	ML

Grass standing crop measurements have important implications for grazing and fire management. A forage flow estimate was thus made for the APNR based on the animal numbers obtained from the annual game count (Figure 6 and Table 6). As discussed with the various APNR management bodies, results indicate that for **the APNR as a whole, grazing stress would vary from stress throughout the winter to sufficient grazing in the following order: UPNR, BNR, KPNR, TPNR and TNR. If we then look at the 2016 and 2015 data, we see grazing shortages from around September and in some cases as early as June 2015. Therefore parts of the APNR have been under varying grazing stress since mid-2015!!** Note that this approximates these parameters and will be refined using energy requirements and flows (see discussion under the animal section). In conjunction with this, it is important to link up with the faecal analysis programme, as it will give an indication of the physical condition of the herbivores (see final section of this report). The 2016 Figure is left in to show the improved situation in 2017.

Table 6 Forage flows in the APNR.

Property	Comment
APNR	Grazing stress in the APNR in some instances from mid-2015 with less stress in the TPNR and TNR as discussed above.

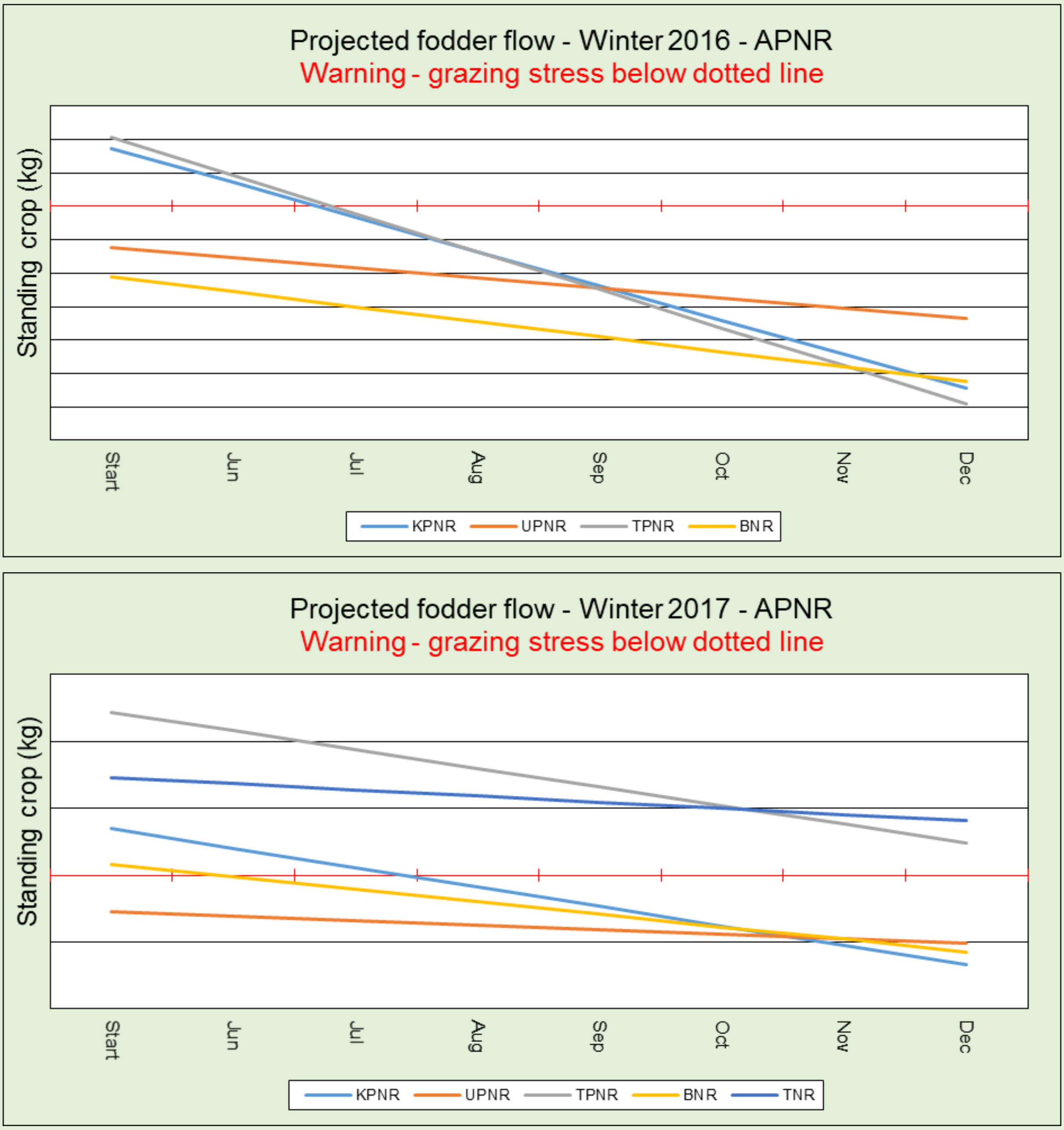

Figure 6 Projected forage flows on APNR for winter 2016 (top) and winter 2017 (bottom).

Table 7 A comparison of the vegetation condition of a number of important grass parameters on KPNR-UPNR-TPNR-BNR and four reserves (with their property number in the ARC-API data set).

Grass Parameter	KPNR UPNR TPNR BNR TNR	Res. 22	Res. 5	Res. 1*	Rank no.: KPNR; UPNR; TPNR; BNR - /8 2009/10-10/11 /6 TPNR and BNR 11/12 onwards /8 16/17 reserve 22 replaces 13 and 8 joins APNR /8													
					03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
Perennials (%)	66 55 79 49 68	57	85	62	5 2 2	5 1 2 8	6 5 2 7	7 5 1 8	5 4 3 8	8 6 1 7	- - 1 6	- - 2 6	8 3 1 7	6 4 1 8	4 2 1 8	3 2 1 8	6 8 4 4	4 7 2 8 3
Cover (distance-mm)	199 193 67 157 71	91	69	77	6 4 3	7 4 5 8	7 6 4 8	8 4 1 7	4 8 3 7	8 7 4 6	- - 1 6	- - 3 6	1 8 7 5	6 7 2 8	6 7 2 8	7 8 3 6	8 7 4 5	8 7 1 6 3
Cover (tuft size-mm)	29 32 37 23 20	14	23	21	4 1 1	3 2 1 8	4 3 1 7	3 4 1 8	6 1 2 8	4 1 1 8	- - 3 6	- - 2 6	7 1 4 8	2 2 1 7	2 2 1 7	3 2 1 7	2 3 1 5	3 2 1 4 7
Standing crop ($kgha^{-1}$)	14 57 472 206 851	251	1213	2073	6 1 2	6 2 3 8	7 5 4 8	7 5 3 8	7 3 2 8	5 4 1 8	- - 3 4	- - 2 6	8 5 2 7	2 5 3 8	5 4 2 7	3 4 2 8	6 4 2 5	8 7 4 6 3

*New insertion south.

For the above indicators, Table 7 ranks the four reserves within the APNR (intra) in descending order as follows: TPNR, TNR, KPNR/UPNR and BNR. Within the study area, TPNR ranks high, TNR moderate-high, KPNR, UPNR and BNR moderate-low when compared to three nearby reserves (APNR overall moderate).

Note that with the changes in weather/climate patterns the prediction is that rainfall in these semi-arid savannas will become less predictable and more variable. As previously stated it could be that we are going to experience greater extremes in rainfall with ‘wetter wet seasons’ and ‘drier dry seasons’ with recent studies predicting more wet than dry highlighting the need for good grass cover. The KPNR, BNR, northern TPNR and UPNR experience drier conditions than the central and southern areas of the TPNR and TNR. As previously discussed, it must also be remembered that the BNR has ‘evolved’ from an area of small fenced properties, often with high stocking rates, to an area where animals can move freely (water notwithstanding) in response to resource availability. The provision of artificial water however results in water dependent animals remaining in areas that they would normally have vacated during certain times of the year. This situation is widespread throughout the APNR. The effect of high impact herbivore species such as elephant must be considered as declines in the grass layer indicate that while rainfall drives the system, grazing pressure can ultimately compromise the composition and vigour (distance and tuft) of the individual grass plants. Grass standing crop measurements have important implications for grazing and fire management. Therefore, in addition to animal number manipulation, the judicious use of fire, bush thinning and the rotation of water points should be used to manage herbivore distribution and impact. Please read the ‘drought’ report[v8] compiled in this regard (Appendix A and Appendix B) and the ‘elephant’ report (under separate cover).

Trees

Woody density varies across the different areas, with fluctuations broadly corresponding to ‘wet’ (decreased density –with an increase in competition with the perennial grass component) and ‘dry’ (increase in density). The long-term tree densities and canopy cover indicate a general gradual decline (Figures 7 and 8). In the various reserves the following: BNR - Long term stability in density but with gradual increases from 2013/14 (Figure 7) and stable tree canopy until 2011/12 after which consistent canopy cover declines (Figure 8); KPNR – relatively stable density with declines in canopy cover since 2012/13; UPNR - long term declines in both density (Figure 7) and canopy cover (Figure 8) in the UPNR - gradual increases in density from 2011/12 (Figure 7) and canopy cover since 2012/13; TPNR - long term declines in both density (Figure 7) and canopy cover (Figure 8) - gradual increases in density from 2011/12 (Figure 7) and canopy cover decline from 2012/13; TNR – long term increase in density with steep increases from 2013/14 (Figure 7) and long term canopy cover relatively stable but declining from 2013/14. The above illustrates the fluctuations one would expect within the tree layer. Given the climatic and concerns of the perceived/real impact of elephant, we have started an in-depth analysis of tree density and cover for the entire study area and results will be reported on as they are analysed and interpreted.

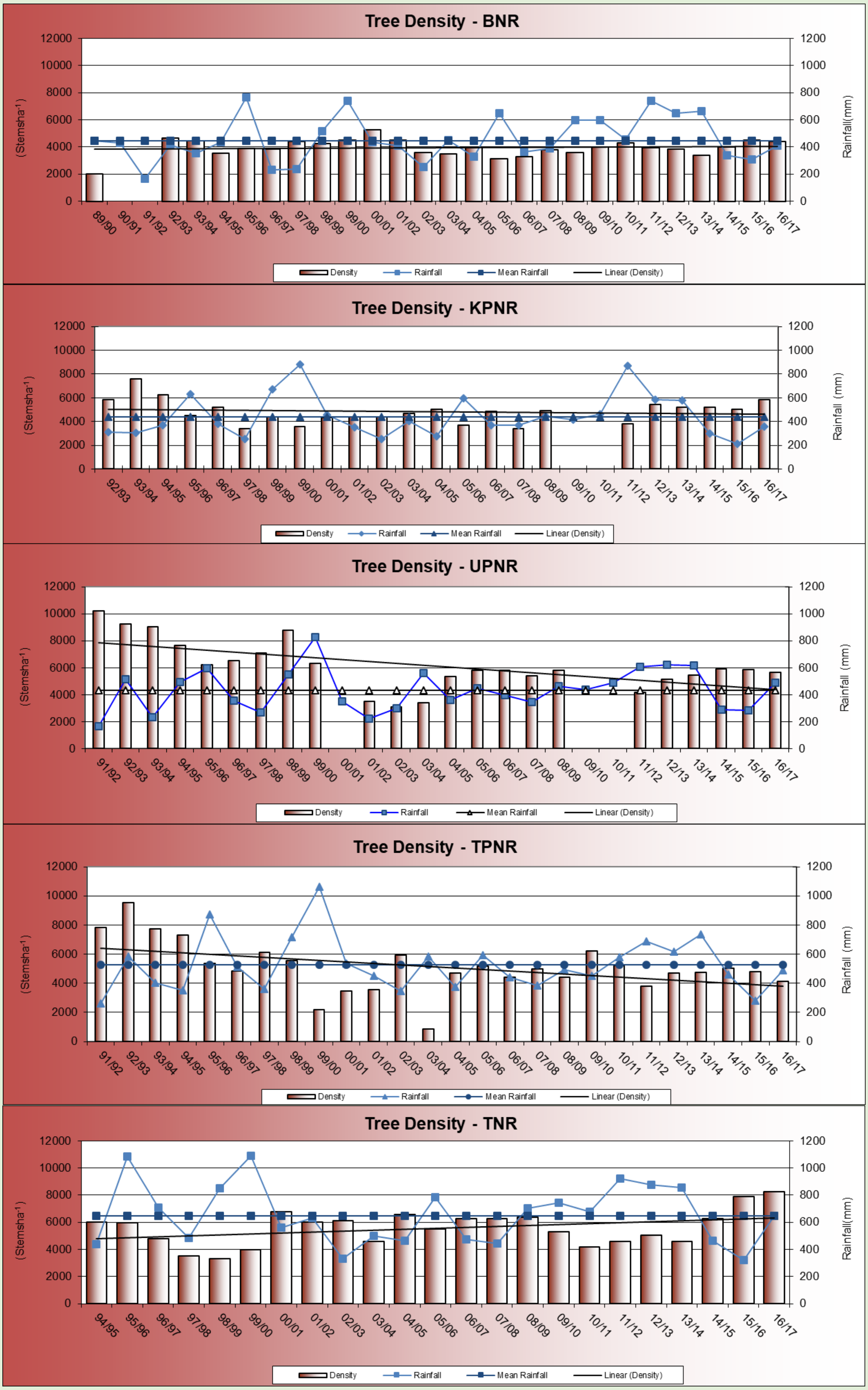

Figure 7 Mean woody densities on APNR and rainfall.

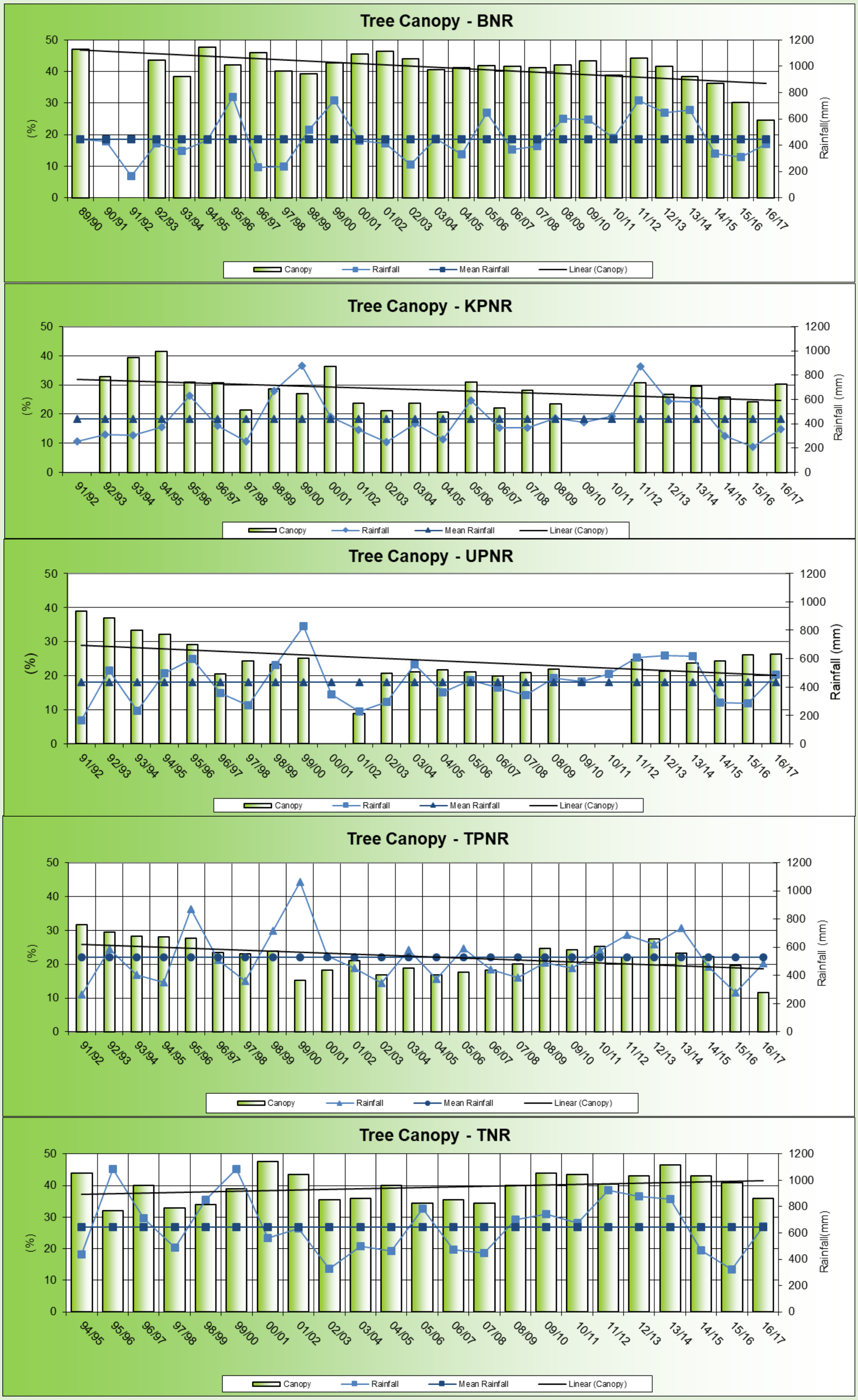

Figure 8 Mean tree canopy cover on APNR and rainfall.

Elephant impact

When we examine the 2007 to 2017 results we note two things: the overall density of elephant has increased in time from 0.69 to 0.84 to 0.80 to 0.73 to 0.96 to 0.96 to 0.93 to 1.19 to 1.57, 1.49 and 1.10 elephant km^{-2} in the APNR. The increases were initially gradual but with a sharp increase from 2014 and a decline in 2017 across the APNR combined (which now includes TNR) and for each reserve with the exception of the TNR where, as expected there was an influx of elephant with the recent removal of the fence with the TPNR. The elephant population is mobile within the APNR (and surrounding areas) and for the individual reserves: BNR (1.07 to 0.39 to 0.65 to 0.59 to 0.81 to 0.7 to 1.33 to 1.63 to 1.56 to 1.42 to 1.37 elephant km^{-2}); KPNR (0.68 to 1.31 to 1.03 to 1.14 to 1.33 to 1.5 to 1.0 to 1.2 to 2.27 to 1.61 to 0.99 elephant km^{-2}); UPNR (0.27 to 0.47 to 0.68 to 0.48 to 0.8 to 0.3 to 0.27 to 0.87 to 0.82 to 0.93 to 0.53 elephant km^{-2}); TPNR (0.62 to 0.84 to 0.72 to 0.49 to 0.72 to 0.91 to 0.87 to 1.01 to 1.24 to 1.7 to 0.87 elephant km^{-2}) and TNR (0.35 to 0.35 to 0.35 to 0.35 to 0.35 to 0.4 to 0.87 to 0.31 to 0.36 to 0.37 to 0.40 to 2.54 elephant km^{-2}).

The severity of elephant impact (Figure 9), ranked on a seven-point scale indicates that the percentage of trees **NOT** impacted upon was: BNR 74% (previous 84% - mean 84%) indicating steep increases in impact in 2017 – mortality increase to 2.9%; KPNR 67% (previous 61% - mean 79%) indicating sharp increases in impact from 2015 onwards – mortality 3.0%; UPNR 50% (previous 51% - mean 76%) indicating sharp increases in impact between 2015 and 2017 – mortality 3.4% from 3.8%; TPNR 63% (previous 60% - mean 78%) indicating sharp increases in impact in 2016 and 2017 in particular – mortality increases in 2016 and 2017 (3.4% and 3.3% respectively); TNR 88% (previous 90% - mean 92%) indicating slight increases in impact in 2016 and 2017 – mortality slight increase in 2017 (1.1% and 3.3% respectively). We would expect an increase in the impact in the 2018 data following the influx of elephant into this reserve.

There was a continued general spike in lower severity classes (4.5% to 63% impact) (particularly in the UPNR and less pronounced in the BNR) indicating **an increase in usage although at lower degrees of impact. The latter may indicate that, due to**

food shortages, the animals are moving through the veld relatively quickly in search of food and not staying in a specific area for any length of time. Increases in impact and mortality generally coincide with elephants focussing on the woody component in dry years due to poorer grass species composition, cover and yield and a concomitant increased impact on the tree layer.

In terms of percentage damage per height class Figure 10 indicates a continued selection within the 2-5m and >5m classes but with a continued marked increase in the impact in the 2.1-5m classes. The northern (drier) areas show increases in the 1-2m height classes as well supporting the above statement that due to food shortages, the animals are moving through the veld relatively quickly in search of food and not staying in a specific area for any length of time while also selecting lower height classes. For the specific reserves when compared to the mean: **BNR** 1.1-2m class: 16% (previous 15% - mean 11%) indicating an increase; 2.1-5m class: 37% (previous 39% - mean 24%) indicating a continued increase; >5m class: 36% (previous 39% - mean 24%) indicating a continued increase; **KPNR** 1.1-2m class: 51% (previous 48% - mean 22%) indicating a continued sharp increase; 2.1-5m class: 58% (previous 60% - mean 33%) indicating a continued sharp increase; >5m class: 64% (previous 61% - mean 32%) indicating a continued sharp increase; **UPNR** 1.1-2m class: 61% (previous 58% - mean 25%) indicating a continued sharp increase; 2.1-5m class: 65% (previous 64% - mean 34%) indicating a continued sharp increase; >5m class: 76% (previous 69% - mean 35%) indicating a continued sharp increase; **TPNR** 1.1-2m class: 47% (previous 50% - mean 23%) indicating a continued sharp increase; 2.1-5m class: 55% (previous 67% - mean 35%) indicating a sharp increase; >5m class: 65% (previous 60% - mean 35%) indicating a continued sharp recent increase; **TNR** 1.1-2m class: 9% (previous 6% - mean 7%) indicating constant impact; 2.1-5m class: 28% (previous 21% - mean 17%) indicating selection for this height class; >5m class: 7% (previous 6% - mean 11%) indicating a reduced impact. These results further support the thinking that, due to food shortages, the animals are moving through the veld relatively quickly in search of food and not staying in a specific area for any length of time. This parameter is monitored, as homogenisation of structure is not desirable (e.g. all small trees or all large trees present and nothing in between). It is interesting to note that TNR has low impact across the height classes compared to the other four reserves. The influx of elephant into TNR will make this an interesting comparison in 2018.

Figure 11 shows the percentage of trees sampled per species, which were impacted upon, and Figure 12 the **relative** percentage of all tree species sampled that have been impacted upon. Table 9 provides a brief discussion of these results.

Table 9 Discussion of impact per species sampled and relative percentage impact.

Species	Reserve	% impacted and comment	Relative % impact
Combretum apiculatum	BNR	27% (32% previous)	10% (27% previous)
	KPNR	35% (38% previous)	22% (19% previous)
	UPNR	42% (38% previous)	8% (5% previous)
	TPNR	41% (41% previous)	37% (29% previous)
	TNR	13% (11% previous)	13% (16% previous)
Colophospermum mopane	BNR*	22% (4% previous)	37% (3% previous)
	KPNR	48% (46% previous)	22% (19% previous)
	UPNR	52% (47% previous)	44% (40% previous)
	TPNR	33% (30% previous)	6% (5% previous)
	TNR	-	-
Acacia nigrescens	BNR	25% (14% previous)	25% (14% previous)
	KPNR	15% (10% previous)	15% (10% previous)
	UPNR	14% (16% previous)	14% (16% previous)
	TPNR	19% (9% previous)	19% (9% previous)
	TNR	15% (9% previous)	12% (11% previous)
Sclerocarya birrea	BNR	- (6% previous)	1% (4% previous)
	TPNR	- (20% previous)	5% (1% previous)
	TNR	15% (15% previous)	6% (5% previous)
Grewia spp.	BNR	1% (20% previous)	1% (22% previous)
	KPNR	44% (42% previous)	35% (37% previous)
	UPNR	59% (58% previous)	32% (35% previous)
	TPNR	36% (45% previous)	26% (30% previous)
	TNR	11% (10% previous)	16% (15% previous)
Mixed *Acacia*	BNR	- (11% previous)	- (13% previous)
	KPNR	33% (36% previous)	4% (4% previous)
	TPNR	42% (36% previous)	8% (4% previous)
	TNR	13% (17% previous)	21% (29% previous)

*new properties contain larger areas of *Col mop.*

The link between elephant density and impact on favoured trees is currently being investigated. *Combretum apiculatum* and *Colophospermum mopane* play similar roles in that relatively similar proportions of these species are selected for where they dominate. *Colophospermum mopane* and *Grewia* spp. will in all likelihood continue to comprise a large proportion of the impact particularly in the drier north and east while in the central, south and west the impact shifts to *Combretum apiculatum*.

As with the tree density and canopy data, a clearer understanding of elephant impact is emerging as the monitoring programme continues. This is not an in-depth study of elephant impact but more an attempt to broadly quantify impact on a reserve scale. Species and areas of concern should be identified for closer investigation within an elephant management plan.

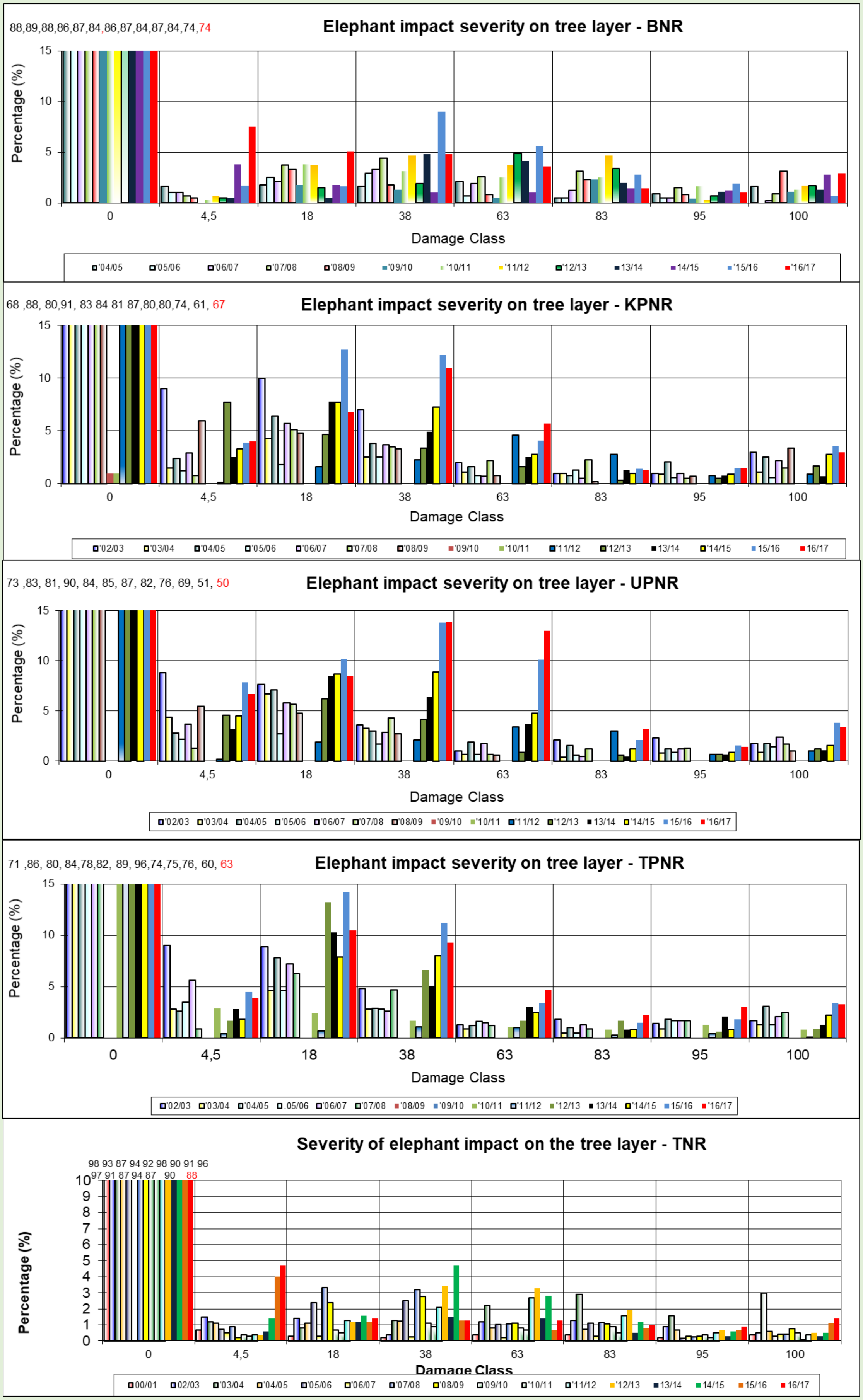

Figure 9 Severity of elephant impact on APNR reserves.

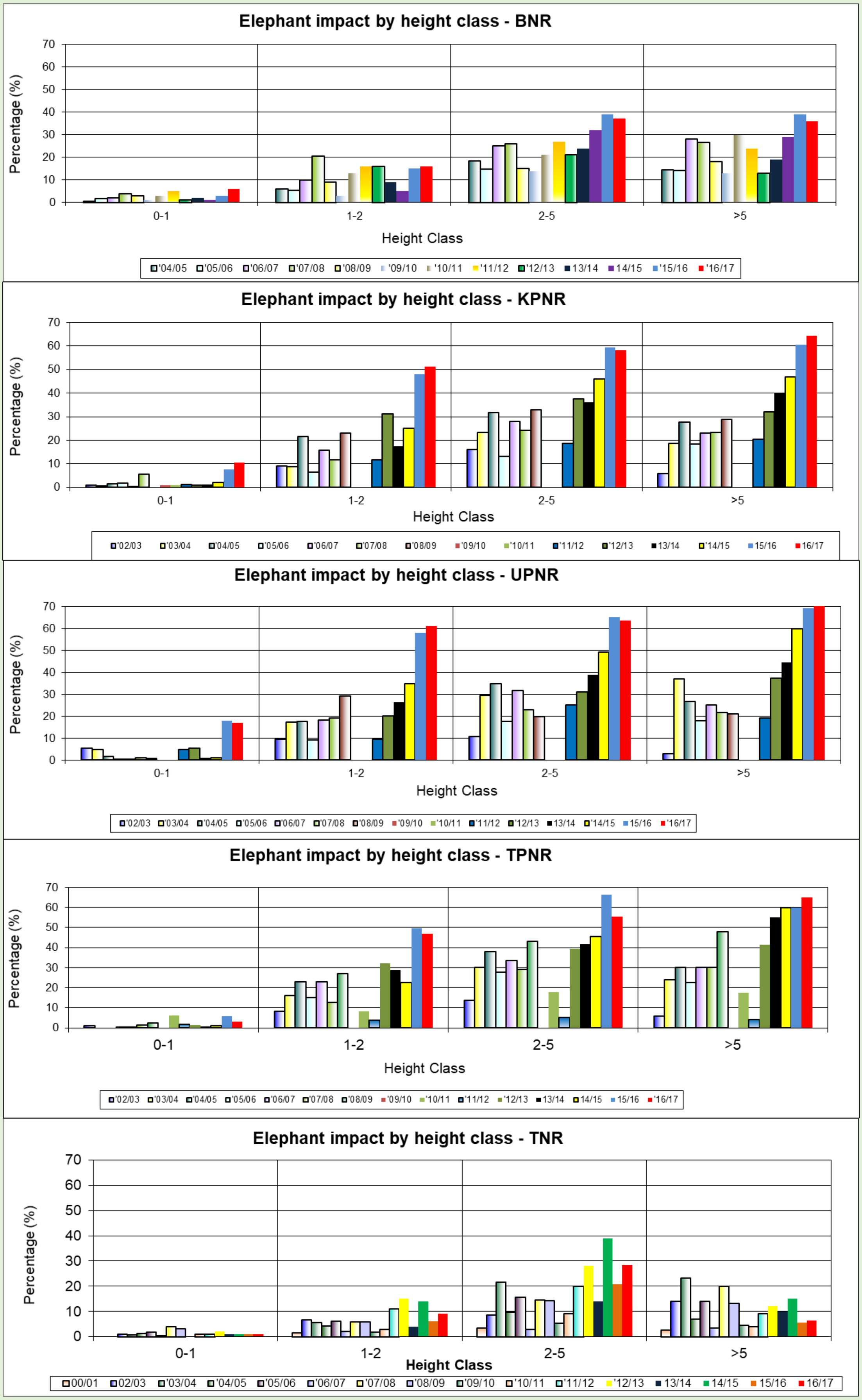

Figure 10 Elephant impact by height class on APNR reserves.

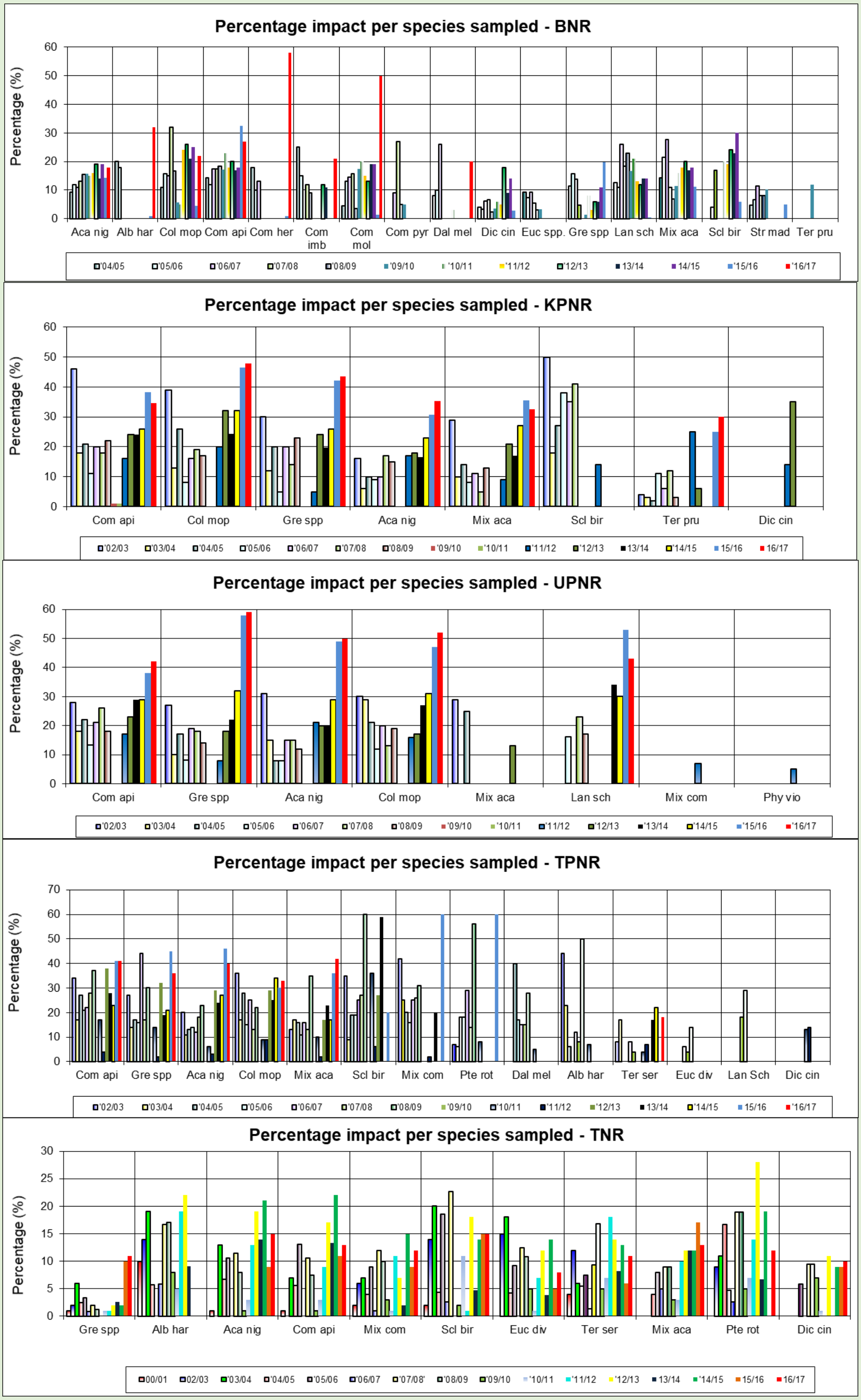

Figure 11 Percentage elephant impact per species sampled on APNR reserves.

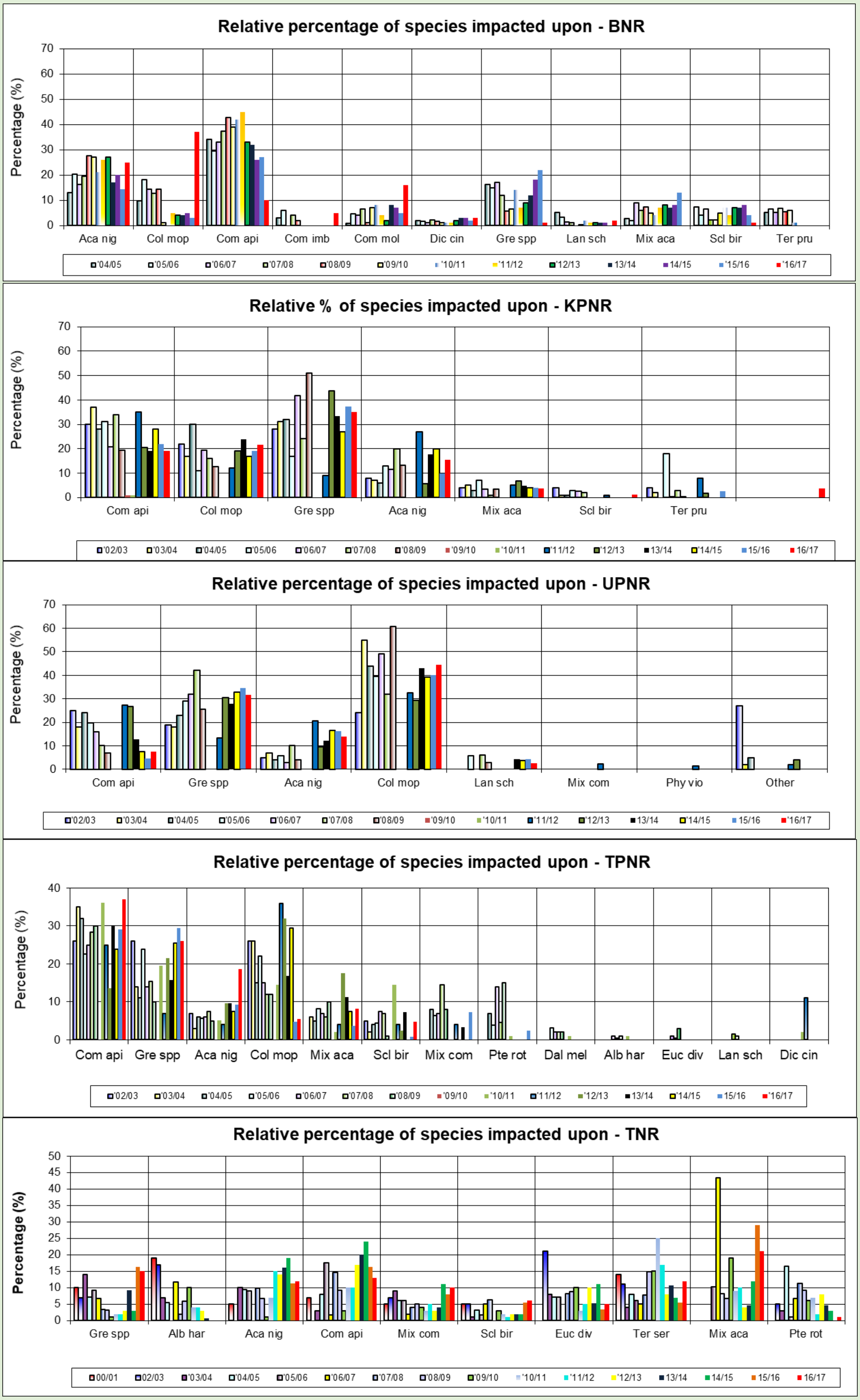

Figure 12 Relative percentage of species impacted upon on APNR reserves.

THE ANIMAL COMPONENT

For the effective management of a game reserve, it is vital to count the animals on a regular basis. These estimates are critical for calculations relating to herbivore carrying/grazing capacity and stocking rate and the effect of their utilisation on the habitat. No form of wildlife management is possible without reliable information regarding herbivore numbers. Because different animals have different effects on the vegetation, it is important to determine the feeding class proportions on APNR. Appendix C presents the combined APNR animal numbers from the 2017 count. Appendix A, B and D are included as they provide important discussion relating to the current drought. Much of the discussion in this section is aimed at augmenting the information contained in **Appendix A** (drought report v8 2016) in particular.

Due to the critical drought, Appendix A and the herbivore management plan (with specific reference to elephant), reported on in 2016, forms an important adjunct to pat reports. After much discussion, version 8 of the former and version 5 of the latter was forwarded to the authorities (MTPA and LEDET), SANParks and DEA.

The 2017 game count numbers were used to calculate stocking rates (Figure 13), feeding class ratios (Figure 14) and to examine herbivore trends (Figure 15) and projections. Numbers (2017) were projected as follows:

1. ‘18proj’ in Figure 13 = the 2017 count numbers plus the estimated natural increase; minus the proposed management/hunting removals (Appendix D); minus the adjusted offtakes due to the current drought (Table 4 Appendix A) but not including possible additional ‘emergency’ offtakes (up to ≈4 100 impala). The latter would be deemed necessary in the event of the situation deteriorating sufficiently to warrant further management action (to be re-assessed winter 2018); re-introductions (0); and the calculated effect of predators (Table 8). The second series in Figure 13 represents the prey biomass only (i.e. taking non-prey animals out of the calculation rhino, hippo and elephant - what will be available to predators).

Table 8 Predator **estimates** for APNR as obtained over time from Colin Rowles, Craig Spencer, Mark Shaw and Almero Bosch.

Reserve / Species	KPNR	UPNR	TPNR	BNR	TNR
Lion	≈ 62 – previous 8♂, 29♀, ≈ 25 cubs	≈ 20 – 8♂, 12♀, - cubs	≈69 – 21♂, 29♀, 19 cubs	≈61 23♂, 32♀, 6 cubs	≈26 2♂, 13♀, 11 cubs
Leopard	≈ 40	≈ 15 – estimate 4 ♂, 8 ♀, 3 cubs	≈50 - 18♂, 28♀, 4 cubs	≈16 - 6♂, 6♀, 4 cubs	≈16 - 3♂, 13♀, 0 cubs
Cheetah	≈ 5	≈ 2 not all year	≈ 20	≈ 6	0
Hyena	≈ 50	≈ 15	≈ 40	≈ 26	≈ 12
Wild dog	≈ 20 – not present all year*	Uncertain	≈ 30 not present all year*	3 – Remainder of introduced pack	0

NNB – These are estimates and are extremely difficult to determine without an in-depth study.

Peel, Kruger and Zacharias (2005) show that appropriate stocking rates, depending on veld condition and reserve location ranges between the Coe *et al.* (1976) upper guidelines of 3 100 kg km^{-2} and 4 000 kg km^{-2} and the agricultural guideline of 4 500 kg km^{-2} and 5 000 kg km^{-2}.

The stocking rate increased steadily from the mid-late 1990's in the APNR, declined quite markedly in 2016 and 2017 yet remains well above the guideline (since around 2008) (Figure 13). In 2017 the stocking rate was:

1. Well above the guideline in the BNR (above to well above 12 of last 14 years – largely due to high numbers of elephant, hippo and buffalo);
2. Above the guideline for KPNR (above since 2005, well above since 2008 but much reduced 2017);
3. above the guideline in the TPNR (above for 15 of last 17 years);
4. Well below the guideline in the UPNR (largely below the guideline since 1996, above 2016);
5. Well above the guideline in the TNR (above to well above 14 of last 15 years – 2017 largely due to influx of elephant) (Figure 13).

When we remove the rhino, hippo and elephant from the stocking rate calculations (essentially the non-prey species) we see that the **prey biomass declined in the APNR in 2016 and 2017** after increasing marginally year on year in since 2010 (with a marked increase in 2015 and the 2014 prey decline due to the fact that only the megaherbivores were counted in the BNR). The latter is largely due to declines in buffalo numbers in the APNR through death and migration. For the individual reserves in 2017 the prey biomass:

1. **Declined** in the **BNR** for second year running (large decline in 2014 a function of not counting species outside of buffalo as prey species)
2. **Declined** in the **KPNR** (second year);
3. **Increased** in the **TPNR** (still low compared 2011-2015);
4. **Declined markedly** in the **UPNR** (the steep fluctuations illustrate animal movement in and out of this relatively small reserve with increased numbers of buffalo encountered in 2016 and much less in 2017 – see Appendix A and B relating to the drought and Peel & Anderson 2016);
5. **Declined** in the **TNR** for third year running due largely to declines in buffalo numbers (large decline in 2014).

As previously stated, the fluctuation in stocking rate in the various reserves within the APNR is due to movement of large mammals (elephant and buffalo) and increased mortality (buffalo). This is highlighted where there has been an influx of animals from the KNP (little natural water and few artificial water points) to the many artificial water points in the APNR (see Appendix A and B relating to the drought and Peel & Anderson 2016). There appears to have been widespread mortality particularly among the grazing buffalo but here is some evidence that this species may have migrated to areas of the KNP where the drought was less severe and where grazing remained favourable. **The latter highlights the need to look at the APNR holistically and in conjunction with the neighbouring KNP – I refer you to my presentation at the Kruger network meeting in 2018 to highlight this sentiment (www.sanparks.org/conservation/scientific_new/savannah_arid/events/savanna_science_network_meeting.php).** In this regard, it is encouraging that we in the APNR are currently collaborating with KNP on an integrated management plan.

Stocking densities throughout the APNR have been well above the guideline in recent years. As we came off a run of ‘good’ rainfall years, we have for a number of years sensitized landowners to the possible effects of a dry/drought period. The question previously asked was “what if we have a poor season where a relatively favourable situation switches quickly to one where we suffer food shortages and concomitant animal die-offs (particularly under heavy stocking densities)?” The strength of the APNR is that it is ‘unfenced’ and relatively large and animals are free to move to areas with better forage resources – which as stated above appears to have happened to an extent. Water dependent species (e.g. impala and wildebeest) are however generally sedentary and often do not move in response to diminishing resources (unlike species such as buffalo and elephant). Therefore, even though the APNR system is relatively large and ‘open’ (although this is not entirely true as there are still fences, people and management that restrict unlimited movement) drought has an impact on the herbivore component. Water provision re-scales the area such that it functions at much smaller spatial scales. This is particularly relevant as discussed in the previous paragraph where the water situation between the APNR and KNP is completely unbalanced (see Appendix A).

Table 10. Comments on stocking rates 2017 in the APNR (see also Figure 13).

<table>
<tr><th>Comments</th><th>Comments (minus elephant)</th></tr>
<tr><td>APNR – above guideline
BNR – Well above guideline
KPNR – Well above guideline
UPNR – Well below guideline
TPNR – Well above guideline
TNR – Well above guideline</td><td>The removal of these mega herbivores results in much altered stocking rates:
<table>
<tr><th>Reserve</th><th>Stocking rate with elephant (kgkm^{-2}) 2017</th><th>Stocking rate minus elephant (kgkm^{-2})</th></tr>
<tr><td>APNR</td><td>6 930</td><td>2 792</td></tr>
<tr><td>BNR</td><td>7 740</td><td>2 585</td></tr>
<tr><td>KPNR</td><td>6 796</td><td>3 084</td></tr>
<tr><td>UPNR</td><td>3 162</td><td>1 171</td></tr>
<tr><td>TPNR</td><td>6 442</td><td>3 176</td></tr>
<tr><td>TNR</td><td>13 399</td><td>3 883</td></tr>
</table>The large decline in stocking rate after elephants are removed from the calculation (and reduction in the proportion of feeding class 3 indicates the significant proportion of the biomass that elephant comprise). The ability of elephant (and impala) to both graze and browse makes them extremely successful competitors. Impala still perform an important ‘buffer’ role in the presence of predation. The low number of wildebeest (and buffalo post the drought) highlights the latter statement and with the ‘boom and bust’ nature of warthog fluctuations, the situation in feeding class 2 remains critical.</td></tr>
</table>

Table 11 Indicating skewed feeding class proportions in the APNR (also see Figure 14).

Comments – current situation

Reserve	Feeding class 1	Feeding class 2	Feeding class 3	Feeding class 4
BNR	Well below guideline	Critically low	Well above guideline	Below guideline
KPNR	Well below guideline	Critically low	Well above guideline	Below guideline
UPNR	Below guideline	Critically low	Well above guideline	Well below guideline
TPNR	Below guideline	Critically low	Well above guideline	Below guideline
TNR	Critically low	Critically low	Well above guideline	Well below guideline

Comments (minus elephant)

The removal of these mega herbivores results in much altered feeding class ratios:

Reserve	Feeding class ratios with elephant (%) 2014				Feeding class ratios minus elephant (%)			
Feeding class	1	2	3	4	1	2	3	4
APNR	19	2	70	9	47	4	27	22
BNR	24	1	68	8	38	2	31	28
KPNR	22	1	70	7	44	3	31	21
UPNR	31	1	66	2	54	1	34	11
TPNR	29	2	64	5	61	6	14	19
TNR	24	1	68	8	32	11	34	23

The situation is not much changed indicating generally high proportions of feeding class 3 due to high elephant numbers. The large decline in the proportion of feeding class 3 after removing elephant from the calculations removal indicates the significant proportion of the biomass that elephant comprise. See above table for additional comment. Feeding class 2 remains critically low throughout.

* rounded off

The actual number trends of the major animal species within the above feeding classes are presented in Figures 15 (a –d) with a combined figure for the APNR (discussed in Table 11).

Table 12 Brief discussion of animal trends in the APNR.

Species	Comment
Feeding Class 1 - Refer to Figure 15 (a)	
Buffalo **	There was a steep decline in the number of buffalo in the APNR for the second year running following a steady general increase in the buffalo population since 1997 (the period under discussion) (Figure 15a-d). Buffalo weaken during droughts and in addition to grazing related mortality, large predators in particular lion target them. As stated above we believe there was also movement to areas where grazing conditions were not as severe. There was a steep decline in buffalo in the KPNR, UPNR, TPNR and TNR. BNR numbers have been low for a run of years now.
Zebra* **	The APNR population continued to increase. In 2017, the numbers increased markedly in the KPNR, TPNR, increased in the BNR, and was stable in the TNR. There was a steep decline in the UPNR.
Waterbuck* **	There was a steep increase in the number of waterbuck in the APNR. There was a marked increase in the TPNR and BNR, stable in the KPNR and declining in TNR. There are very few waterbuck in the UPNR. Historically numbers increased markedly with the inclusion of the BNR (2005).
White rhino **	The white rhino population continued to decline in 2017 but remains at relatively high levels. There was a decline in the number counted in the TPNR and BNR, continued low numbers in the UPNR, stable in the KPNR and a decline in the TNR (including some translocation). The threat of poaching and grazing shortages is of grave concern. We cannot afford to lose this species to both poaching and drought and alternatives, such as proposed to management by the author should be thoroughly explored.
Feeding Class 2 - Refer to Figure 15 (b)	

Species	Comment
Wildebeest* **	The wildebeest population in the APNR exhibited a marked increase prior to the inclusion of BNR, which certainly bolstered the population. There was an initial decline in the population in the year after BNR's inclusion but the trend in 2007 and 2008 was positive. The population stabilised in 2009 but this was followed by a continued decline in 2010 and 2011. There was a continued marked increase in the APNR population in 2017. These increases may be related to predators and particularly lion switching their prey target to buffalo in the past three dry/drought seasons. Wildebeest numbers increased in the TPNR and BNR, declined in the UPNR and markedly so in TNR and was stable in the KPNR. **All efforts must be made to ensure that the wildebeest population remains viable**. In addition to predation, the contribution of habitat change to declines in species such as wildebeest should also be investigated.
Warthog **	The warthog population increased overall. This population will continue to exhibit fluctuations in response to wet (boom) and dry (current - bust) conditions. Count conditions also influence the warthog count. There was a decline in numbers in the TPNR and TNR (drought), small increase in UPNR, increase in BNR and stable in KPNR in 2017.
Feeding Class 3 - Refer to Figure 15 (c)	
Elephant **	The elephant population declined in 2017 (their ability to move). There was sharp decline in elephant in the TPNR, UPNR and KPNR. Increase in the BNR with the addition of the Maseke property in particular and TNR with the removal of the fences with TPNR (expected).
Impala **	The impala population increased in 2017. There were declines in the KPNR, TPNR and TNR and steep increases in the UPNR, BNR (additional properties).
Feeding Class 4 - Refer to Figure 15 (d)	
Giraffe* **	The population increased markedly for the third year running. The number counted was stable in the TPNR; declined in the UPNR (small population), TNR and KPNR; increased in the BNR (new properties making the difference). In addition to the lion – giraffe dynamic, the results highlight the fact that giraffe is a species that also moves over quite extensive areas.
Kudu* **	Kudu numbers increased in the APNR. There was an increase in the UPNR, KPNR and BNR; stable in the TPNR; declines in the TNR. The overall healthy kudu numbers may be related to a thickening up of trees due to elevated CO_2 in the atmosphere. In addition to this, there is some evidence that elephant may facilitate browsers by reducing the height of taller trees.

Species	Comment
Black rhino **	31 black rhino were counted in the APNR.

*These populations tend to decline under increased predation to a point where they drop to numbers that cannot be sustained (i.e. cannot produce enough to stop the population declines i.e. a predator pit). With the removal of fences, there has obviously been movement between the reserves and the KNP. This is very evident when one looks at the recent relatively stable game populations but with often-wide fluctuation within the APNR. ** See Appendix A, B and Peel & Anderson (2016) for discussion around animal trends in the APNR in 2015 and 2016.

The early positive contribution of BNR in terms of animal numbers is evident from previous year's counts as this area experienced more intensive (predator) management in the past due to it being fenced. This is again underlined by the addition of more land into the BNR and the addition of the TNR contributing to increases in the numbers of various species. The challenge remains to manage the APNR in such a way that the animals move in response to the mosaic of varying food resources – this seems to be happening but not necessarily due to management. The previous APNR management plan was signed by the MEC of Mpumalanga in May of 2011 and recommended for approval by C. van Zyl of LEDET in July 2009*)*. It is now required to write the management plans for the individual reserves comprising the APNR and, as stated earlier these are complete at first draft stage for KPNR and TPNR and in prep. for UPNR, BNR and TNR.

Preliminary 'Thresholds of Potential Concern' are available and emphasise the importance of setting the limits of acceptable change. The tenuous position of certain prey species on the one hand (see above) and high densities of mixed feeders (elephant and impala) illustrate this on the other hand in the APNR. It is recommended that preliminary TPCs for herbivores on APNR are set on the basis of measurable criteria such as proportion of the total biomass a species constitutes, estimated rates of increase and survival, impact on other species and vegetation, as well as an element of predator impact, calving percentage and survival and calving interval. Should a population move outside the limits of the TPC, the situation must be investigated and remedial action taken where practicable.

The dry 2014/15, 2015/16 and 2016/17 seasons has had a marked impact on the herbivore populations in the APNR (read Appendix A and B). The following are some thoughts I have relating to animal management and drought. Over the past two years, we see that the grass layer has been limiting for grazers in general in the APNR. Further, I think that given the fact that buffalo move in large herds over extensive areas and are not sedentary around a single water point that they have a generally beneficial effect on the vegetation for, among others, the following reasons. High densities of large hooved animals:

- Break soil crusts by their hoof action allowing for a good soil surface to seed contact;
- Reduce the height of moribund grass, thus allowing sunlight to penetrate the shorter vigorous grass tufts while reducing the temperature of the soil and making it more suitable for rainfall infiltration; and
- Deposit concentrated amounts of dung and urine.

All of the above promotes seedling establishment, particularly in bare areas and promotes a healthy productive perennial sward of grasses. Closer plant spacing (increased density) with a better litter layer (organic matter) and stable soils results in less evaporation and more effective rainfall (infiltration) with lower soil temperatures, less rainfall runoff, silting up of streams etc. The presence of predators, in particular lions, causes the herd to bunch when chased thus intensifying the positive impacts outlined in points 1-3 above.

The fact that these large herds **are mobile** also means that they seldom ‘camp’ on a patch for a long period of time but are continually moving through different areas. Data relating to the movement of the buffalo (and other species) herds on APNR would be useful in supporting or refuting this statement – we have spatial data from the game counts but restricted temporally. This means that unlike selective water dependent grazers, buffalo will utilise an area and then move on thus reducing the chance of overgrazing. Overgrazing occurs because of excessive artificially supplied surface water and the resulting high densities of sedentary water dependent species (e.g. impala). I emphasise that animal control should be considered where water point provision has resulted in increased animal numbers due to their increased distribution in a reserve and resulting insufficient forage for animals during dry periods (obviously critical in fenced situations and under the current drought conditions). The alternative is that the population is allowed to fluctuate with the prevailing conditions, i.e. a die-off in drought (weaker animals). The tricky issue if the latter option is pursued is the effect on the food resources resulting from such a ‘laisse-faire’ approach and the potential effect on species such as white rhino, which are already under pressure due to poaching. Ultimately, some debate would need to be entered into in this regard to gauge the feeling of the landowners in consultation with the managers/ecologist working on the reserve.

The fact that, due to fencing in earlier days, there was no longer movement to the higher rainfall areas and more reliable forage resources in the west near the mountains means that there would be losses in drought years. These population declines would vary from minimal to sharp but may be viewed as part of a long-term cycle (unlike warthog that follow a boom and bust cycle over short time periods due to their selective feeding behaviour). Droughts are also times when lions feast on weakened buffalo herds. Ultimately, the critical decision to be taken is whether we are prepared to allow drought related mortality to occur and whether the cost to the veld would be acceptable if numbers were allowed to increase unchecked. Preliminary data indicates that there may have been movement of mobile species such as buffalo to areas where the drought has been less severe.

I would welcome discussion using the energy flow model (see below) that yields the number of animals required to minimise grazing stress. In addition to the fact that the system is open to the KNP, the influence of favourable rainfall years and drought on vegetation cover has obvious implications for, among others: fire, herbivore dynamics and interactions, predator-prey relations, counting conditions and ultimately game numbers. In addition to the data collected by management, much information exists within the current landowner and lodge structure. I would be willing to assist in the collation and presentation of any such data collected within the APNR. We at ARC-API continue to enjoy the collaboration on ecological issues between the various wardens, researchers and landowners in the area. See Appendix A and Peel & Anderson (2016) for a detailed discussion in this regard.

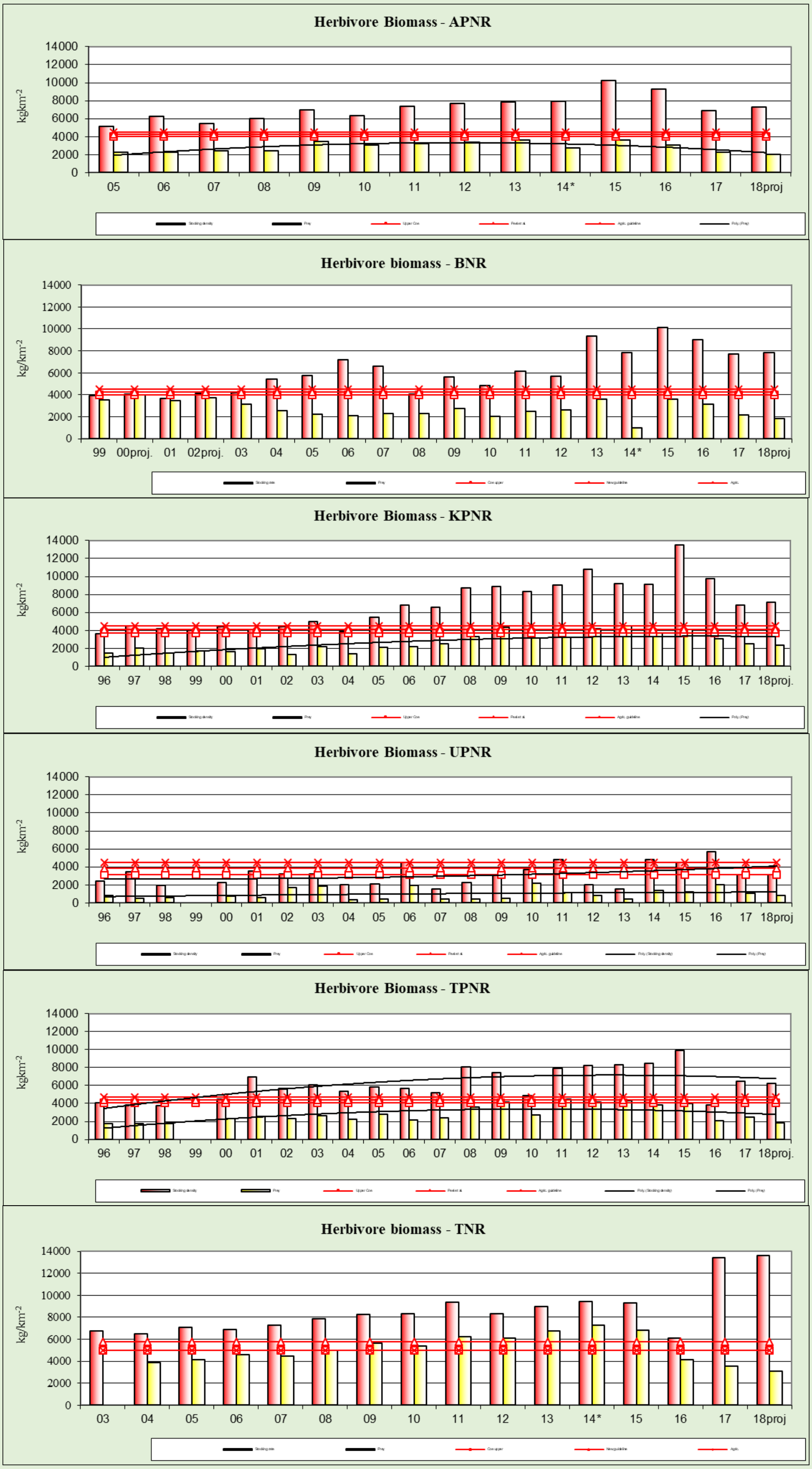

Figure 13 Animal biomass (kg km^{-2}) in the APNR (*2014 only megaherbivores counted in BNR) (2017** including Maseke, Thornybush, Amsterdam and and Excellence).

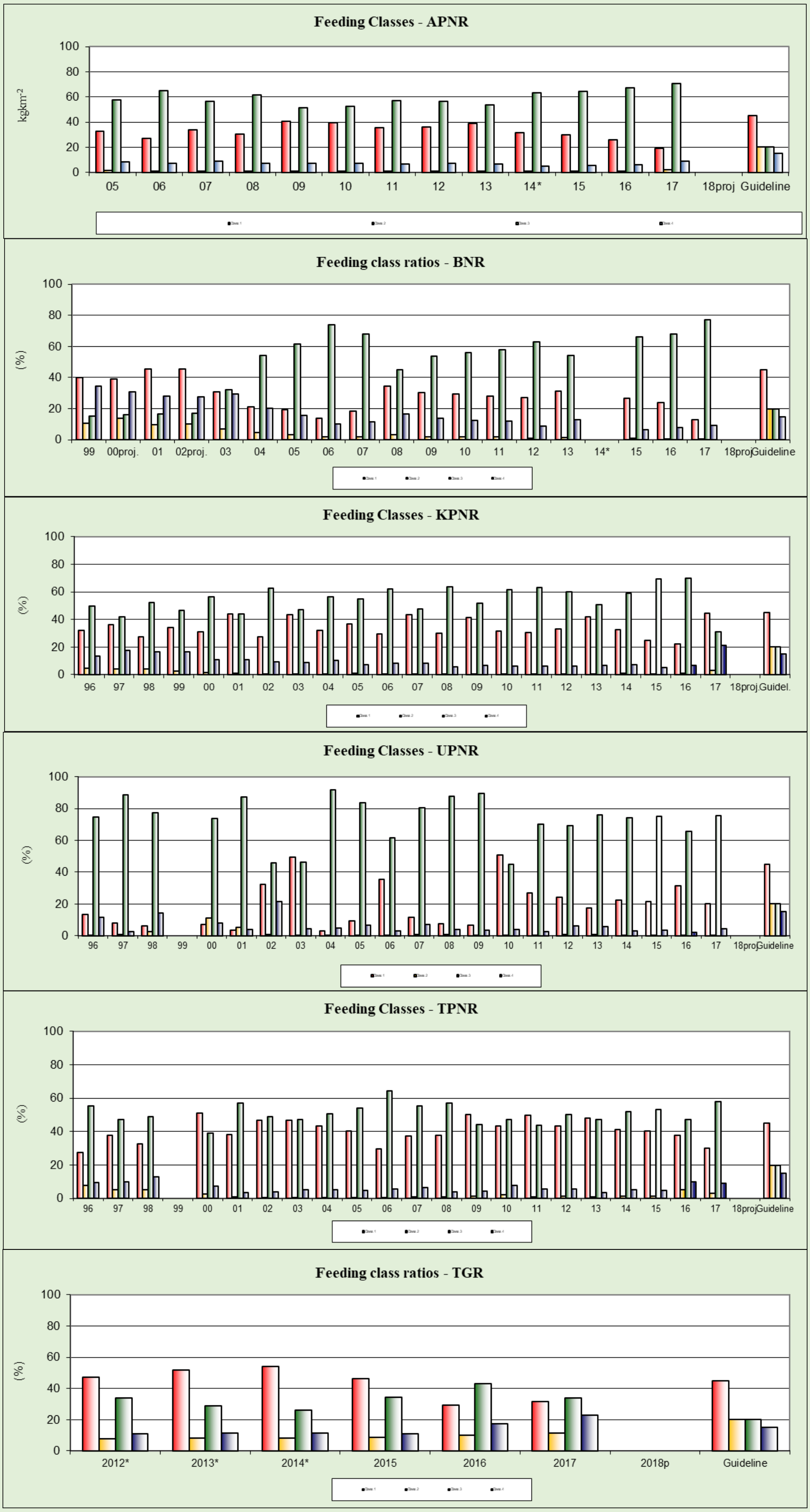

Figure 14 Feeding class ratios in the APNR (*2014 only megaherbivores counted in BNR).

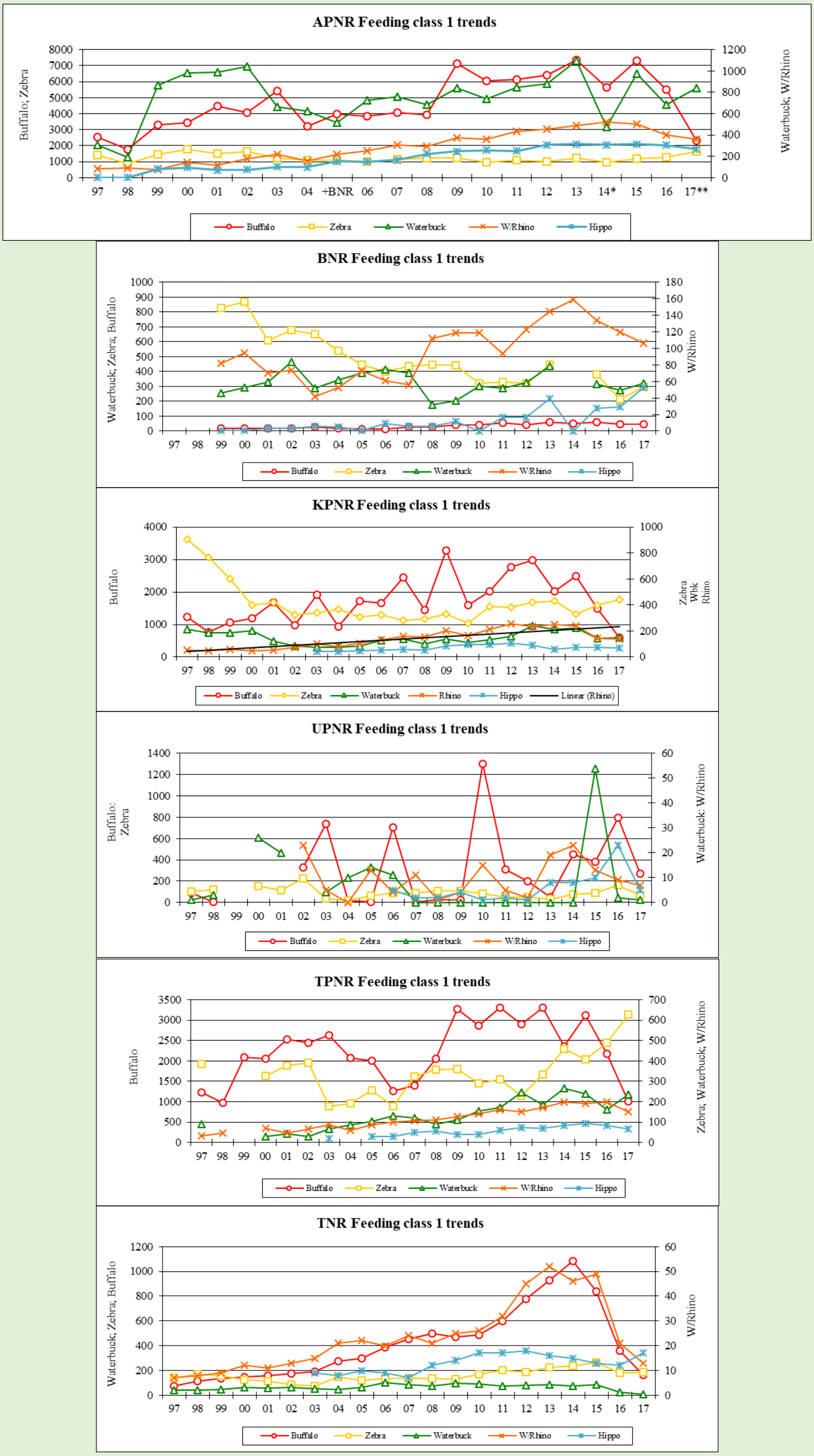

Figure 15a Large herbivore trends in the APNR (feeding class 1) *For 2014 only species that were also counted in the BNR count.

Figure 15b Large herbivore trends in the APNR (feeding classes 2) *For 2014 only species that were also counted in the BNR count.

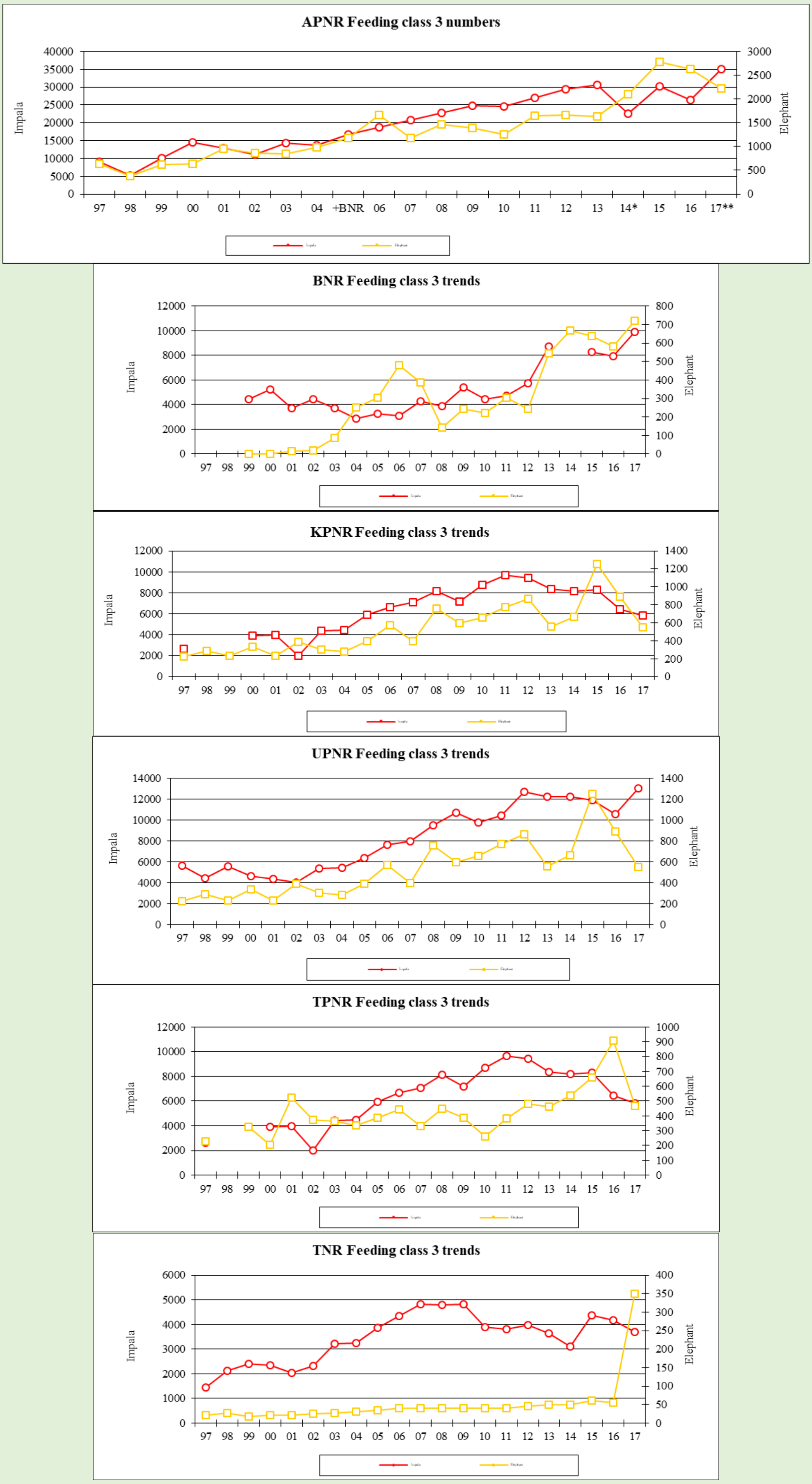

Figure 15c Large herbivore trends in the APNR (feeding class 3) *For 2014 only species that were also counted in the BNR count.

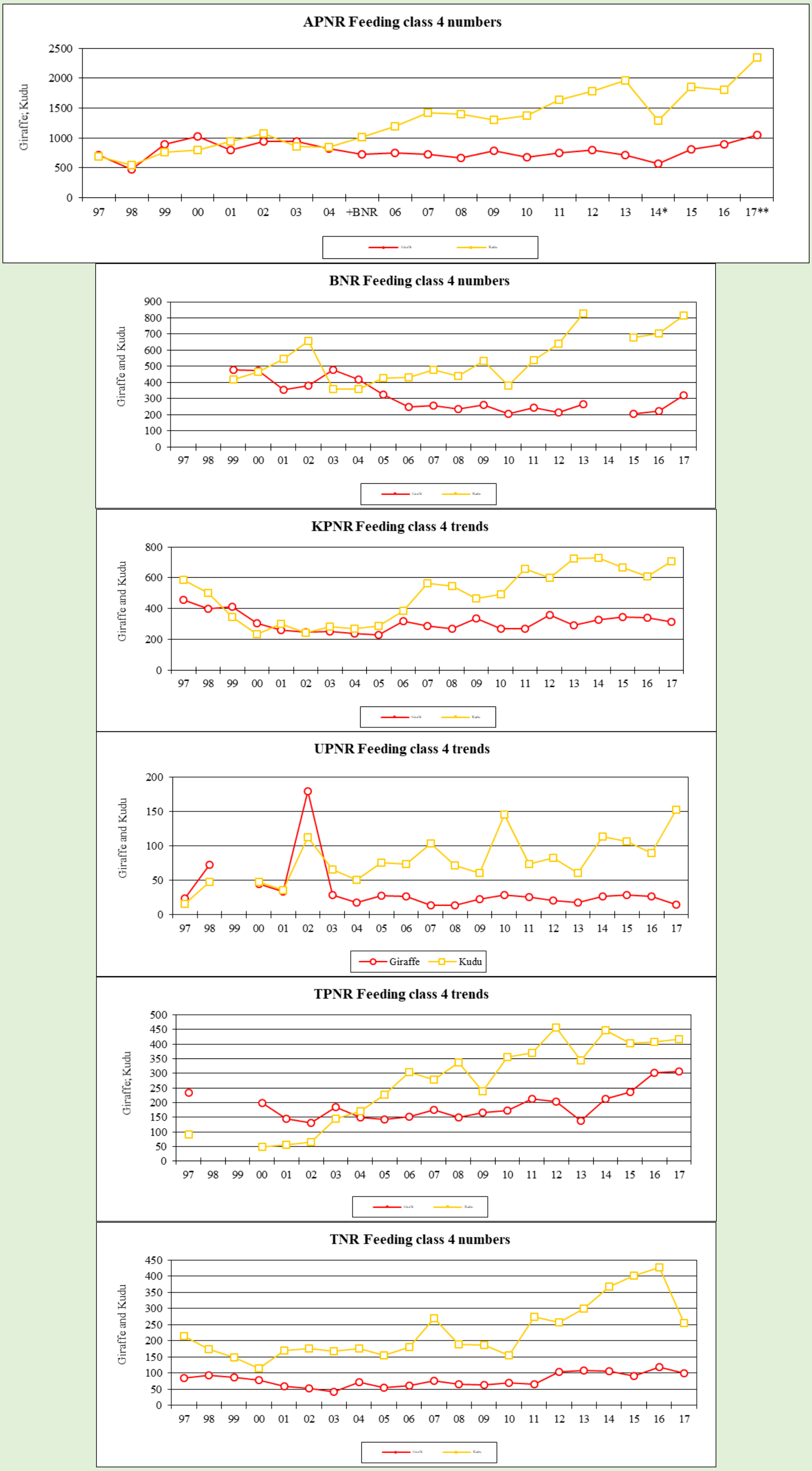

Figure 15d Large herbivore trends in the APNR (feeding classes 4) *For 2014 only species that were also counted in the BNR count

Energy flows and sustainability in the APNR

We examined the effect of resource use by grazers by inserting the resource requirements for wildebeest, warthog, impala, waterbuck, zebra, buffalo, hippo, rhino and elephant. I investigated whether the individual populations were able to stabilise their own 'population metabolism' using flows of endosomatic energy (food and work) (Peel 2005). The average energy demand of the different species was obtained from which an estimate of the activity patterns as they affect the feeding requirements of the various species. The approach is looked at in terms of useful energy flows into a system minus a certain fraction that is reduced by internal overheads (e.g. consumption used to maintain the population) and external overheads (e.g. predation that reduces the population). Where an indicator of environmental loading (EL), the biophysical cost of the diet, is introduced. The EL relates to the metabolisable energy of the forage (ME = 10.5 $MJkg^{-1}$ dry matter - Lombaard 1966) and the total amount of forage (from field data collection in this study). The latter takes into account the proportion of the forage that is available to the animals. Estimates vary from 22% to 49% in the broad-leaved savannas to between 15% and 80% in fine-leaved savannas (in highly nutritious systems). As discussed with management during 2017, using this method, Figure 16 shows that in the northern reserves the resource **was limiting for** the grazing species in the **KPNR, UPNR and BNR (third year running)** while there was sufficient grazing further south in the TPNR and TNR. Note that once the grass layer is depleted (resulting in an energy deficiency for grazers) mixed feeders (elephant and impala) will switch to the woody (browse) component thus increasing the impact on this layer. See Appendixes A-D for updated data in this regard and the need for urgent management action.

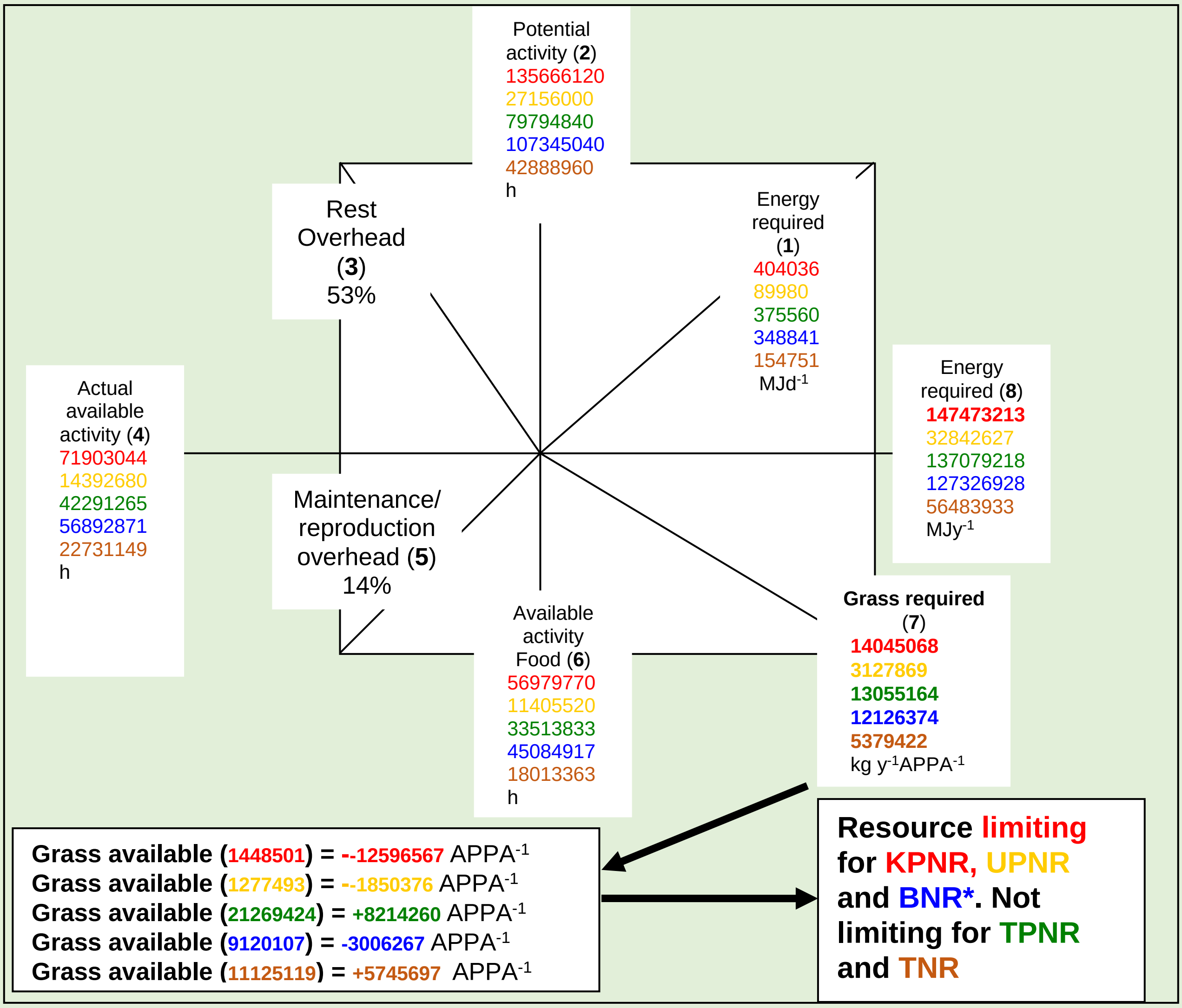

Figure 16 Resource availability in a multi-species grazing system – APNR 2017 (KPNR - red; UPNR - gold; TPNR - green, BNR - blue third year of grazing stress, TNR - orange).

An amount of 1 % of the total value (not hunting) of the animals present on a reserve is considered reasonable when deciding on doing a game count (ABSA 2003). Game values were obtained from various sources including wardens from the area. I assume 1% for the vegetation and faecal analysis-monitoring programme (not including the cost of land, infrastructure etc.). Table 13 summarises the situation for the APNR reserves based on the 2017 game count:

Table 13: APNR estimate of costs as a proportion of the value of animals present.

Species	Total Value (R)	(1) Total cost of vegetation monitoring and faecal analysis per annum (Exc. Vat) (R)	(2) Total cost of helicopter count @ say R7 500 per hour (Exc. Vat) – say 75h (R)
Black rhino	16275000	≈214 172	645 000
Buffalo	130893750		
Bushbuck	456125		
Elephant	16680000		
Giraffe	8308125		
Hippo	10174500		
Impala	34496438		
Kudu	6116756		
Nyala	3396938		
Warthog	259329		
Waterbuck	2595656		
White rhino	98891053		
Blue wildebeest	2593500		
Zebra	4881206		
Crocodile	2145000		
Steenbok	385369		
Ostrich	20475		
Cheetah	618750		
Lion	8211000		
	347398969		
Cost of ecological monitoring (1) and (2) as percentage of value of game (%)		(1) 0.06	(2) 0.19
Cost of ecological monitoring as percentage of value of game (%)		0.25	
Recommended percentage (%)		2.0	

* - Estimate of what the reserve would currently receive per animal – from managers in the area; **- Mean of estimated male and female costs.

The above indicates that the cost of the various ecological monitoring exercises is well within the guideline for the APNR reserves.

FAECAL ANALYSIS

Seventeen reserves have extended their ecological monitoring programme to include looking at animal condition as an adjunct to the ARC-API veld-monitoring programme. Dr Rina Grant, Research Co-ordinator for the Northern Plains Project in the Kruger National Park, is collaborating with us on this project.

Protein is the most common nutrient that limits animal performance and survival. Faecal protein, measured as faecal Nitrogen (N), gives an idea of what the animal is able to select. The measurement is correlated with forage digestibility, dietary protein, phosphorous concentration and weight change. Phosphorous (P) is commonly limiting during dry periods in particular. P is important in energy storage and as a part building block of bones and teeth, (it is thus important in lactation). P deficiencies generally lead to reduced reproduction rates. The higher the protein and phosphorous concentrations and digestibility the greater the palatability of the plants. Environmental conditions affect N and P concentrations and rainfall in particular is correlated to their availability.

The paper by Grant, Peel, Zambatis & van Ryssen 2000 (reference given under **REFERENCES**) is available on request.

RESULTS AND DISCUSSION

Faecal samples have been received from the BNR for a number of years. In 2017 samples were only received from Olifants West out of the entire APNR. This is a pity given the drought we are experiencing. The results of previous analyses are presented in Figure 17.

Results show that the N levels for grazers are generally lower than those for mixed feeders and browsers thus supporting the premise that in these savanna systems the grass layer is the limiting layer. This is illustrated by the results obtained in the current drought conditions. The results for N levels for Olifants West for 2015 and 2017 respectively indicate the following relative to the guideline for: buffalo – at guideline - nothing received 2017; zebra – below - nothing received 2017; impala – above – well above; elephant – well below - above; giraffe - well above – well above.

The results for UPNR for 2015 indicate the following relative to the guideline for: buffalo – below; wildebeest – well below; impala – above; giraffe – well above; kudu – well below.

The results for P levels for Olifants West for 2015 and 2017 respectively indicate the following relative to the guideline for: buffalo – below - nothing received 2017; zebra – well below - nothing received 2017; impala – guideline - well above; elephant – well below - well below; giraffe – guideline - above. The results for UPNR for 2015 indicate the following relative to the guideline for: buffalo – below; wildebeest – below; impala – guideline; giraffe – above; kudu – below. P levels were generally low in the APNR in 2015 (see implications given above)

I would encourage pooled samples as this gives us an idea of the situation within the population and not just a single animal. Data are also largely discontinuous and therefore of limited value and I encourage the various reserves within the APNR to make use of this valuable animal based system indicator.

Consistent data collection and the pooling of greater numbers of animals per sample (and including a spectrum of sex and age classes) will allow us to monitor N and P levels in relation to threshold's that may indicate a dietary deficiency (N) or P deficiencies that may lead to low reproductive rates. As previously requested sex and age data, lambing/calving rates and survival/mortality (related to sex and age) could prove to be an important adjunct to the faecal analysis and by extension the ecological monitoring programme as a whole (Appendix E).

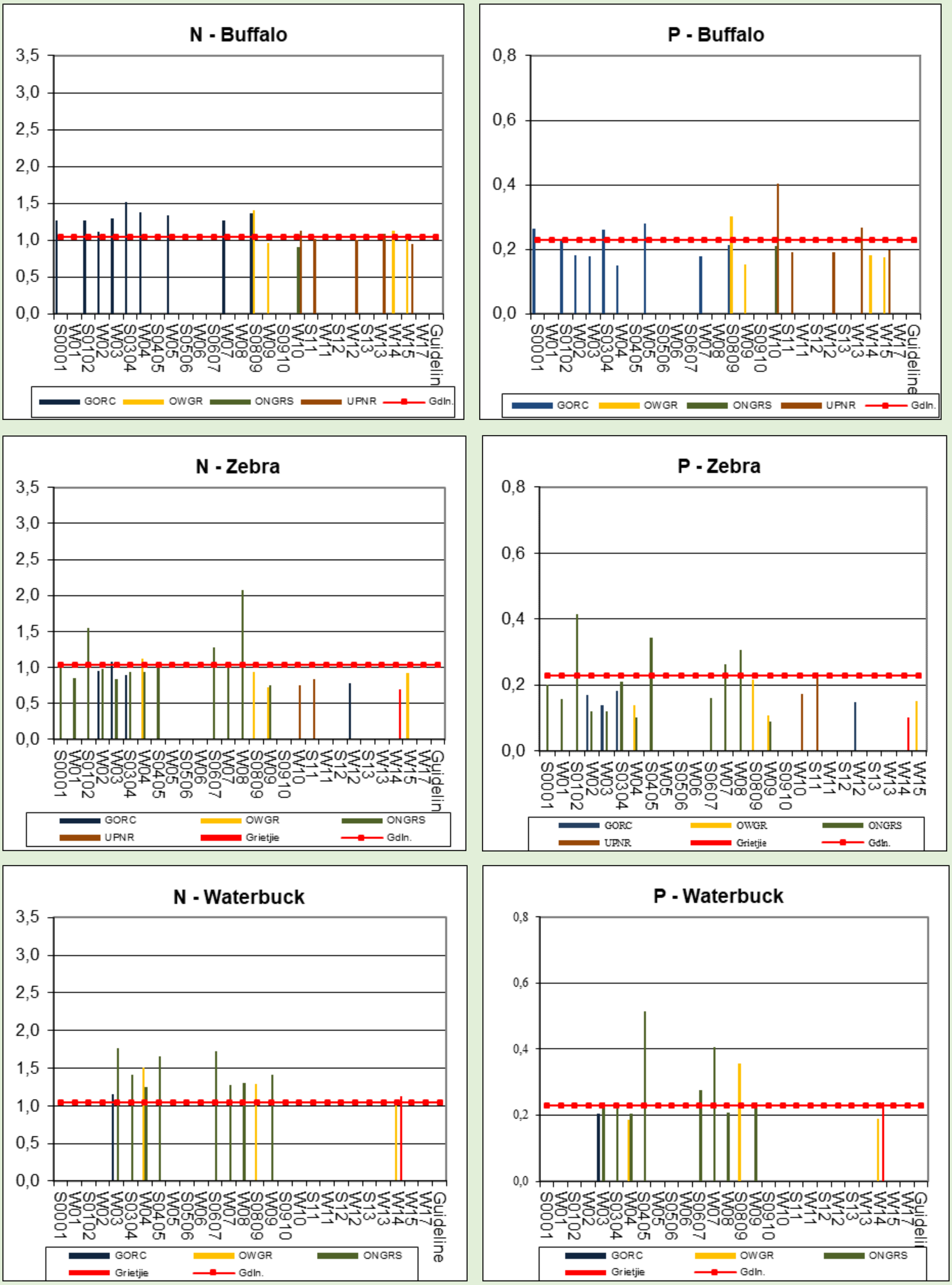

Figure 17 N and P trends in some herbivores on APNR where: S = summer collection and W = winter collection

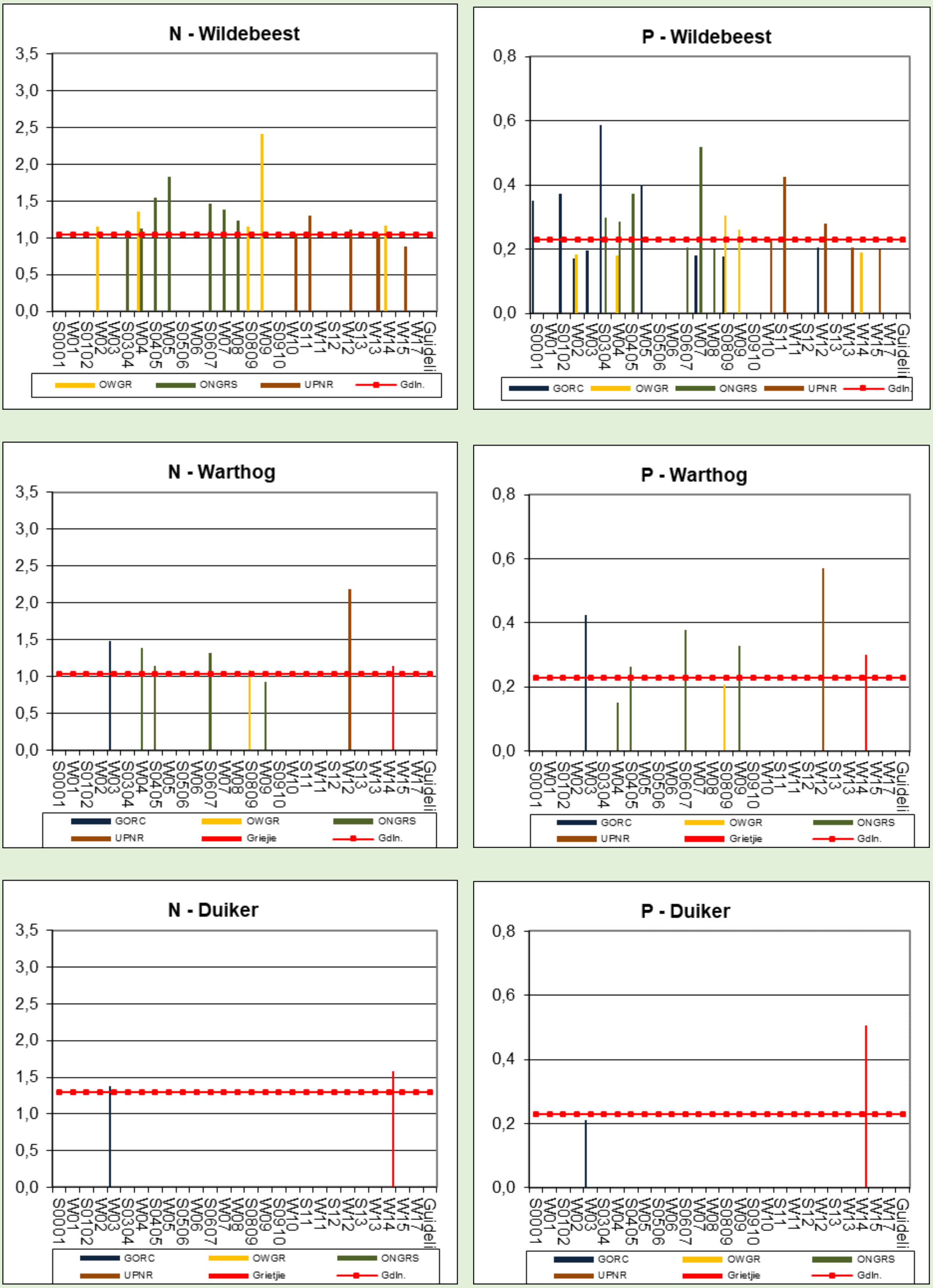

Figure 17 (cont'd) N and P trends in some herbivores on APNR where: S = summer collection and W = winter collection.

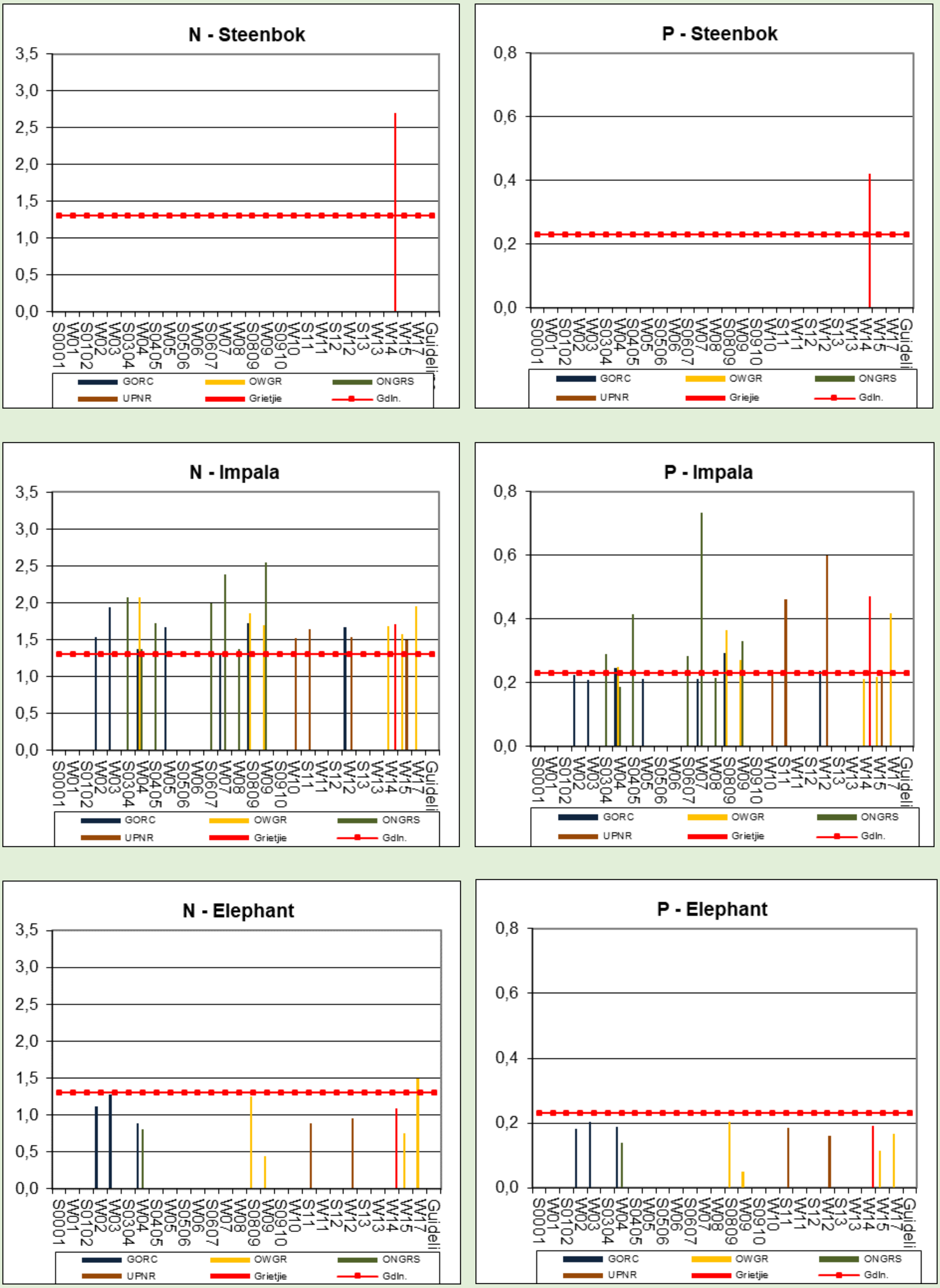

Figure 17 (cont'd) N and P trends in some herbivores on APNR where: S = summer collection and W = winter collection.

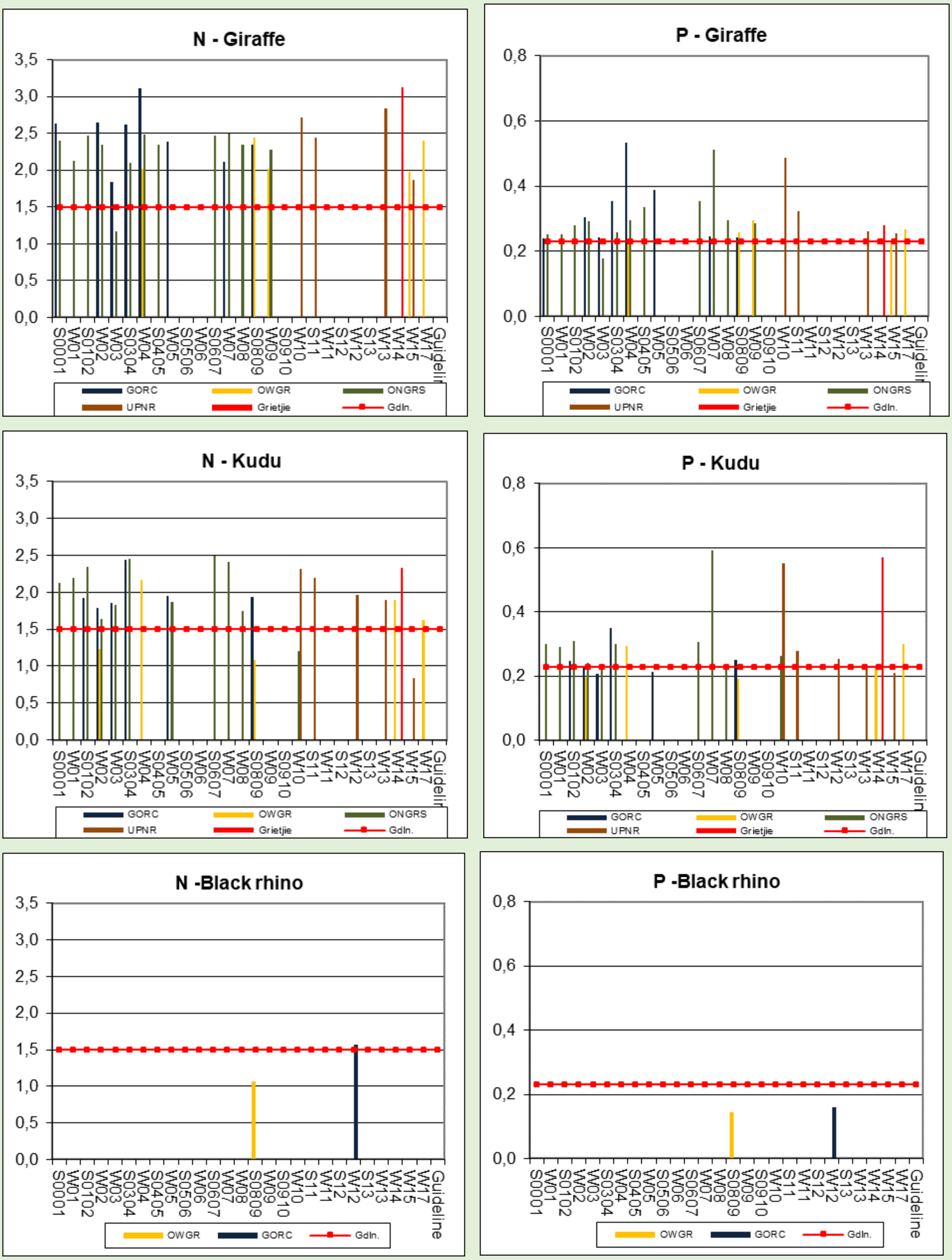

Figure 17 (cont'd) N and P trends in some herbivores on APNR where: S = summer collection and W = winter collection.

The APNR is in an excellent position in terms of information available for the management of herbivores and, where reliable trends are sought, the value of regular consistent counting methods and teams cannot be overemphasised. The importance of the ecological monitoring programme is apparent, as any change in management actions will interact with climatic conditions to influence the vegetation component.

Overall, the monitoring programme has received excellent support from all members within the APNR. The addition of TNR represents a valuable asset and also with an outstanding record of ecological data available. We have a database from which sound management decisions are made, where hazards can be avoided and opportunities grasped to the benefit of the properties. I thank all concerned for the keen interest shown in this project and would like to restate that I am available to discuss the ecological monitoring programme with you at any time.

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Appendix A

Correspondence relating to management response to current drought - APNR.

FOR CONSIDERATION: CHAIRMEN AND WARDENS APNR (v8)

12/04/16

Klaserie, Balule, Umbabat and Timbavati Representatives

Attention Colin Rowles (Reserve Warden Representative)

Dear Colin

GRAZING SITUATION AND OFFTAKES 2016: APNR

This report is a follow up on the letter dated 06/12/15 and correspondence dated 26/01/16 that I (MP) wrote to the wardens of the APNR (the latter document to chairpersons as well) and expressing my concern around the critical grazing situation within the APNR. With the reduction in water points in the Kruger National Park (KNP) the current vegetation situation is unlike in the recent favourable rainfall years where species such as elephant, buffalo and impala increased in number resulting in high stocking densities and feeding ratios skewed in favour of mixed feeders (elephant and impala) (Appendices after references). We are into the second season of drought and the fact that there is reduced surface water in the neighbouring KNP will ultimately 'force' game to enter the adjacent protected areas such as the APNR. While these animals may return to the KNP their presence in the APNR is adding pressure on the already stressed grazing situation. The soaking rains over the past few days will obviously alleviate the situation but grass growth will still be limited given the lateness of the rain – so the challenge remains.

The letter is also prompted by our request made at the DEA/SANParks/Provinces meeting held on the 16th Feb 2016 at Skukuza. The request was that, in view of the time lag involved in getting a quota approved, whether it would be possible to submit and increased quota now – with the proviso that if by May is was not considered necessary then the extra removals would not be implemented. All state agencies agreed to this proposal.

This summary repeats some of that discussion but is expanded to provide context of where we stand in the APNR in relation to the KNP with respect to objectives and management in particular and the potential implications of these differences in terms of plant-animal interactions. This document is therefore presented as follows:

1. An executive summary highlighting recommendations;
2. A summary of the letter sent to wardens in December 2015;
3. Objectives relating to protected areas;
4. Protected areas functioning at different scales due to management (fencing and water in particular) and climate change (not covered here but to be noted);
5. Management in the light of the current drought situation.

I look forward to taking the process forward.

Sincerely

(Mike Peel and Jeremy Anderson)

(COPY DR JULIUS TJELELE (ARC-API)

MR. COLIN ROWLES TO CIRCULATE

1. Executive Summary

a. Large private nature reserves (e.g. the APNR) adjacent to the KNP have embraced the basic philosophies of the KNP management approach since the removal of the fence between them, have similar general objectives but function on different spatial scales. In the latter areas movement is possible but, due to size (spatial scale) and management issues such as water provision these areas present a unique set of management challenges (from point 3);

b. The summary letter sent to wardens in December 2015 predicted grazing shortfalls in 2016 and the need to increase management offtakes to just cover grazing requirements (point 2). However only sustainable yield quotas – or even less were requested (Table 1). The drought has worsened and these numbers are now considered far too low and require appropriate adjustment;

c. An over-supply of water in protected areas adjacent to the KNP led to an eruption of relatively water dependent herbivore species. The higher concentrations of animals resulting in increased grazing, trampling, dunging and urination which in turn affects water infiltration, run-off, grass cover, species composition, the tree:grass ratio, and ultimately biodiversity and sustainability (from point 4). The KNP has closed more water points which exacerbates the situation and the probability of large numbers of animals entering the well-watered APNR (estimate 1 water point 731 ha^{-1} in the APNR vs 1 water point 51 440 ha^{-1} in the KNP. As previously stated the recent soaking rains will obviously alleviate the situation but grass growth will still be limited given the lateness of the rain – so the challenge remains;

d. Water provision is clearly the major factor here - is there a possibility of somehow equalising the density of water between the APNR and the KNP?; We do not necessarily suggest reopening water points in the KNP but closing more in the APNR. The areas to be selected should be proposed by the individual reserves themselves as a matter of urgency (e.g. to protect a stand of charismatic tree species;

e. The following are considered the minimum offtakes (live where possible and additional to the hunting quota) to alleviate the current drought situation (there will still be losses if these offtakes are effected) – buffalo ≈ 1 450 (add another 500 if considered necessary); impala ≈ 9 700; elephant ≈ 330 (but up to 1 000 if considered necessary); white rhino ≈ 100 (but up to 150 if considered necessary); hippo ≈ 45 (but up to 100 if considered necessary); and

f. Method of offtake is aimed at immediate action. Live removals of white rhino and hippo is essential; Large scale contraception of elephant is considered feasible in the middle term and should be considered as a matter of urgency under the guidance of Audrey Delsink – but this will only become effective in time which in the current situation we do not have; Live removal of all species is preferred and we need to list the properties that have been approached to illustrate the lengths to which we have gone to try and move the animals live. Where all of these avenues have been exhausted then culling must be considered in the short term until the contraception programme becomes effective. In this regard an incredible opportunity exists to initiate the 'wildlife economy' in communal rangelands e.g. Andover and others. For this opportunity to be exploited (and it could be an excellent public relations exercise for private protected areas to contribute animals to communal protected areas) authorities need to get these areas fenced immediately and expedite logistic issues such as permit issuing, staffing etc. – the expertise exists to determine range condition and the number and type of animals that these areas could accommodate.

2. Summary of letter sent to APNR Wardens December 2015

We examine the effect of resource use by grazers by inserting the resource requirements for wildebeest, warthog, impala, waterbuck, zebra, buffalo, hippo, rhino and elephant to determine whether the individual populations (using 2015 counts and projecting forward to 2016) can be sustained on the grass available in 2015 and an estimated grass biomass following a dry/drought 2015/16 season.

Results and Discussion

Following a poor 2014/15 rainfall year the mean grass standing crop within the various APNR areas was:

KPNR 879 $kgha^{-1}$; UPNR 863 $kgha^{-1}$ (corrected from estimated 532 $kgha^{-1}$); TPNR 1 482 $kgha^{-1}$; BNR 257 $kgha^{-1}$.

Energy flows and sustainability in the APNR

We examined the effect of resource use by grazers by inserting the resource requirements for wildebeest, warthog, impala, waterbuck, zebra, buffalo, hippo, rhino and elephant. I investigated whether the individual populations were able to stabilise their own 'population metabolism' using flows of endosomatic energy (food and work) (Peel 2005). The average energy demand of the different species was obtained from which an estimate of the activity patterns as they affect the feeding requirements of the various species. The approach is looked at in terms of useful energy flows into a system minus a certain fraction that is reduced by internal overheads (e.g. consumption used to maintain the population) and external overheads (e.g. predation that reduces the population). Where an indicator of environmental loading (EL), the biophysical cost of the diet, is introduced. The EL relates to the metabolisable energy of the forage (ME = 10.5 $MJkg^{-1}$ dry matter - Lombaard 1966) and the total amount of forage (from field data collection in this study). The latter takes into account the proportion of the forage that is available to the animals. Estimates vary from 22% to 49% in the broad-leaved savannas to between 15% and 80% in fine-leaved savannas (in highly nutritious systems).

As discussed with management during previous years and again in 2015, using this method, the resource was not limiting for the grazing species in the KPNR, UPNR and TPNR. However there was a grazing shortage for BNR.

I then projected forward to 2016 taking only the 2015 numbers into account (with reduced increments due to drought/no predation/no natural mortality) and then removing the grazer offtake requests as per the APNR offtake committee correspondence of 2015 as follows:

Table 1 Indicating the initial grazer and mixed feeder offtake requests approved by LEDET, MTPA and SANParks.

Species	KPNR	UPNR	TPNR	BNR	APNR
Buffalo	92	23	54	54	223
Elephant	6	6	11	10	33
White rhino		1	19		20
Hippo			2	1	3
Impala	1 500	450	1 700	1 000	4 650
Warthog	10			13	23
Waterbuck			1	8	9
Zebra			1		1

The results were as follows for 2015:

1. KPNR at 560 $kgha^{-1}$ (less than this received in 4/13 years measured) for 2016 would suffer grazing stress. Theoretically, there are a number of scenarios we could look at but the number to be removed to have sufficient grazing at that grass standing crop would be 200 impala and 60 buffalo;
2. UPNR would be okay from around 300 $kgha^{-1}$ if the offtakes are effected. There is also quite a bit of movement in and out of this reserve;
3. TPNR at 510 $kgha^{-1}$ (less than this received only in 1/16 years measured) for 2016 would suffer grazing stress. Theoretically, there are a number of scenarios we could look at but the number to be removed to have sufficient

grazing at that grass standing crop would be 80 buffalo (given the high buffalo numbers);

4. BNR at 450 $kgha^{-1}$ (less than this received in 7/17 years measured) for 2016 would suffer grazing stress. This indicates that during dry/drought times it is quite feasible that we will have a low standing crop. Theoretically, there are a number of scenarios we could look at but the number to be removed to have sufficient grazing at that grass standing crop would be 200 impala and 80 buffalo.

The above just serves as an illustration of the necessity for proactive management in dry/drought times and the need for the reserves to look at adapting their offtake proposals. This is not to say die-offs will not occur among weaker animals and we also know that in the browser component species like kudu (especially adult male kudu) go into the winter in relatively poor condition after the rut. So at the end of winter they are much weakened and a poor winter and rain and cold snaps can result in large scale die-offs.

I am wary to reduce prey species such as wildebeest, zebra and waterbuck because the lion population has the ability to relatively quickly push them into a predator pit. This is also a time when lions target the weakened buffalo population so their removal needs to be carefully considered. All the while the grazing resource will be stressed so time is of the essence.

The above assumes a drought situation and the potential need to accelerate removals in the event of a poor season. We have reached a situation where relatively large numbers will need to be removed. The worst case scenario is that we suffer a drought and lose animals and where but some pressure will have been taken off the veld through removals; we will recoup something from offtakes. The best case scenario would be that we do not suffer a drought and the veld holds out and where: some normal attrition would take place; pressure is taken off the veld; we recoup something from offtakes.

Insert 2016: leading on from the above we can now say that the bulk of the summer rains have failed and a second year of drought is upon us (again despite the recent rains). **So while the proposed offtakes as given above were a minimum to maintain the grazing component it is now imperative that we adapt our management again particularly in the light of the changed surface water situation.** For this we need to provide some context.

3. Objectives relating to protected areas

The following Table does not represent the actual objectives of the APNR or the KNP but outlines the philosophy relating to setting objectives for protected areas and the importance of spatial scale in setting realistic objectives.

Table 2: Issues relating to objectives, spatial scale (size) – OR why we don't manage all areas in the same way.

Philosophy/High Level Objective	Relevance: Large National Park e.g. KNP	Relevance: Protected Areas (smaller) e.g. APNR
Maintain essential ecological processes and life support systems	High	Moderate
Preserve genetic diversity	High	Moderate
Sustainable utilisation of species and ecosystems	Moderate-low	High

So while the APNR and KNP have a broadly similar philosophy, spatial and temporal heterogeneity at different scales are prime determinants of system qualities. Heterogeneity is an important consideration in any operation based on the use of natural resources, for example, the Kruger National Park (KNP - *c.* 2 000 000 ha) has adopted the Noss (1990), definition of biodiversity as an underlying basis for their revised management plan (Braack 1997a; Braack 1997b) which is expressed operationally in terms of so-called 'thresholds of potential concern', endpoints of which even include the desirability of having a certain limited percentage of land in a 'degraded' condition for a period of time due to biodiversity considerations (we need to ask the KNP (Marisa?) if this philosophy has changed but either way the spatial scale issues are relevant). **Large adjacent private nature reserves (e.g. the APNR) which embrace the basic philosophies of the KNP management approach since the removal of the fence between them, have similar general objectives but function on different spatial scales. In the latter areas movement is possible but, due to size (spatial scale) and management issues such as water provision these areas present a unique set of management challenges**. In the latter case 'island populations' are more likely to undergo more extreme eruptions in numbers and related vegetation over-utilisation than in larger 'open' systems which are waterless for parts of the year (e.g. Owen Smith 1983).

4. Protected areas functioning at different scales due to management (fencing and water in particular) and climate change;

The living requirements of wild animals include food, water and cover. Large herbivores are limited by the amount of nutrients and forage available to them. In addition to this, herbivore species differ in their dependence on surface water. The spatial and temporal distribution of water therefore plays a major role in determining the distribution of herbivores and by extension the condition of the soils and vegetation.

The sub-division of land and the fencing off of conservation areas in the savannas of the north-eastern Lowveld of South Africa began in the late 1960's. This broke the natural east-west herbivore migration and, because many of the fenced off areas did not have perennial water, artificial water points had to be constructed. The result was a network of artificial water points in the Lowveld supplying ‘excess’ surface water in these areas.

Such an over-supply of water led to an eruption of relatively water dependent herbivore species such as impala, wildebeest and zebra around such water points, the higher concentrations of animals resulting in increased grazing, trampling, dunging and urination which in turn affects water infiltration, run-off, grass cover, species composition, the tree:grass ratio, and ultimately biodiversity and ‘carrying capacity’. Many artificial water points therefore may have a negative impact in terms of resource degradation which is directly related to increased animal activities. The figures included in the Appendix illustrates; The increase in herbivore biomass with an increase in rainfall (in particular impala and to a lesser extent elephant extent – buffalo have also increased sharply in the past few years); The increase in animal biomass in the APNR and the skewed feeding class ratios dominated by mixed feeders (largely impala and elephant) which are highly successful and competitive species due to their ability to switch from grazing to browsing. So this year we can expect an increase in tree impact by elephant (to potentially undesirable levels) due to a depleted grass layer. In addition to this the high buffalo numbers will result in increased competition with white rhino and possible related mortalities (this cannot be entertained and live removals of both is essential). Hippo are also likely to come under pressure and removals are essential (live).

To illustrate the current water situation we compare the density of open water points in the APNR (Rowles *pers. comm.*) and the KNP (within a 10km strip in the KNP Coetzee *pers. comm.*). The data are being continually updated (see Figures below and summarised in the Table that follows).

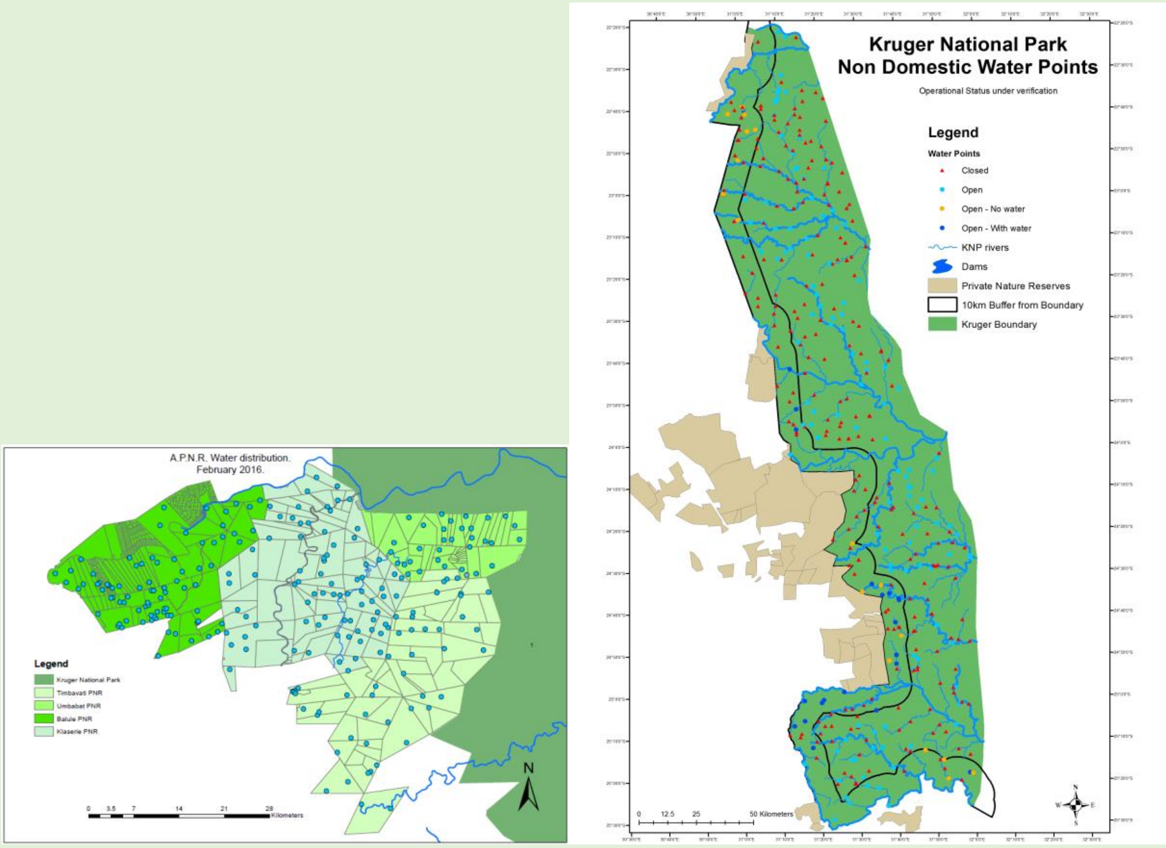

Figure 1 indicating open artifical water points in the APNR and in the KNP (focusing on the area adjacent to the SSW, Manyeleti and APNR).

Table 3 presenting the current density of water points in the APNR (Rowles *pers. comm.*) and KNP (Coetzee *pers. comm.*).

Protected Area	Density of open water points (ha open water point^{-1})	Density of Kruger water points (ha open water point^{-1}) in adjacent KNP*;**	To equal the density open water points in the adjacent APNR the KNP would need *n* water points (left figure in this column) vs actual open (right figure in this column)
Balule*	488	26 540	54 - 0
Klaserie**	719	26 540	37 - 0
Umbabat	805	13 330	17 - 0
Timbavati	1 136	38 110	34 - 0
APNR overall	731	51 440	70 - 0
APNR 10km buffer bordering KNP	Area water point^{-1} = to be inserted once received from KNP	51 440	To insert

*Although BNR does not border directly on the KNP we took the area in KNP that corresponds to the area between the southern- and northern-most boundaries of the PA; ** for the KPNR there is a small area that is adjacent to the KNP but the calculation was made as for BNR.

We are informed that the KNP has closed a large portion of their artificial water points (awaiting details) and in the vicinity of the APNR. The large disparity in the density of water between the APNR and the KNP has obvious implications for game distribution. There is generally more natural surface water during 'wetter' years but under the current worsening drought conditions we expect movement (probably large scale) from the 'less watered' KNP areas to the well/excessively watered APNR. The following, refers to the 1982/83 drought in the Klaserie. Stocking densities in the KPNR, similar to the single grazing capacity figure laid down by Agriculture, resulted in a large scale herbivore population crash subsequent to the 1982-83 drought (from Peel 2005). The cause of the population crash was precipitated by the provision of artificial water points which allowed water dependent animals in particular to increase to artificially high numbers and to alter the habitat to suit their needs. This in turn resulted in a decline in the spatial heterogeneity of the natural resources and extensive grass mortality which was exacerbated by the drought (Walker *et al.* 1987).

5. Management scenarios in the light of the current drought situation – to manage or not to manage

As stated above, with the water closures in KNP we can expect further movement into the APNR. The current grass standing crops will be well short of what they were last year and which formed the basis of my offtake proposal under point 1 above (in addition to the hunting offtakes) that was sent to APNR wardens in December 2015.

We have started our vegetation surveys in the wetter south of the Lowveld (historically high grass biomass) and we are measuring now and will re-measure at the end of the wet season to get an idea of the available grass biomass. Early results indicate grass standing crops of 300 $kgha^{-1}$ and generally less. The drier north (APNR) will therefore in all likelihood be sitting at around 200 $kgha^{-1}$ or less (even if we have late rains (as we are) the rangeland is unlikely to bulk up significantly). Balule will in all probability be in an even worse situation when we consider the 2014/15 season results.

The numbers of buffalo and impala to be removed in a 300 and 100 $kgha^{-1}$ situation, using 2015 numbers (with reduced increments, including hunting quotas and zero predation for a 2016 estimate) is as follows:

Table 4 – adjusted offtake (**starting immediately**) proposal for the APNR for 2016.

Reserve	Buffalo	Impala	Elephant**	White rhino*** (live)	Hippo	Comment
Balule	54 ; 400	1000 ; 1 500	10 ; 100	0 ; 10	1 ; 30	Still grazing stress
Klaserie	92 ; 500	1 500 ; 4 000	6 ; 100	0 ; 50		Still grazing stress
Umbabat	23 ; 40	450 ;150	6 ; 30	0 ; 1		Sufficient grazing
Timbavati	54 ; 500	1 700 ; 4 000	11 ; 100	1 (hunted) and 18 (live) ; 32 (live)	2 ; 15	Still grazing stress
Emergency additional – May 2016	≈500		≈700	≈ 50 live	≈55	

*Offtake quota first number, additional offtake second number and emergency offtake third number; **dispersive shooting (e.g. the Rhodesian (now Zimbabwe) experience of culling a female from the herd and the resulting dispersion out of the area for up to three months. In this instance it may be that less animals will need to be managed); *** live removal or removal while retaining a share of the animals – NNB buffalo are starting to compete with the rhino grazing and we cannot afford to lose rhino to drought and poaching. Other species removals per the hunting quota are not included here but are supported as per previous correspondence.

The main mitigating factor for intense management is the current water situation relating to the closure of water points in the KNP. To summarise from point 1 above: The ‘assumed’ drought has materialised and we need to accelerate removals or risk large scale animal losses and resource (in particular grazing) degradation which may take years to recover. As stated above: We have reached a situation where relatively large numbers will need to be removed. The worst case scenario is that we suffer a drought and lose animals but some pressure will have been taken off the veld; we will recoup something from offtakes. The best case scenario would be that we do not suffer a drought and the veld holds out and where: some normal attrition would take place; pressure is taken off the veld; we will recoup something from offtakes.

There is evidence of the KNP elephant population ‘stabilising’ – we need confirmation of this. Given the gravity of the situation, the requirements for immediate game reduction is clear and in the following table we outline some of the options with their usefulness in the short term with comments (from Henley August 2014 – from the Norms and Standards for Managing Elephants in S.A.) and moving from least to most disturbance.

Table 5 indicating actions and comments relating to potential for immediate action regarding elephant.

Action	**Comment**	**Time**
Do nothing	Acceptable in a man-induced situation?	N/A
Manipulate the environment to control elephant distribution and their effects	Close water – unlikely in APNR to the required density to match KNP; Dispersive shooting (e.g. the Rhodesian (now Zimbabwe) experience of culling a female from the herd and the resulting dispersion out of the area for up to three months – in this instance it may be that less animals will need to be managed); Bees/chillis	Immediate Immediate but difficult large scale in the short-term. Difficult feeding bees in drought conditions
Translocation	Depending on destination – but seems to be few 'takers' in this regard	Immediate – funding required
Contraception	Audrey Delsink has outlined a protocol that may be useful and for relatively large numbers in the future	Immediate – but time lag to take effect so not an option in the short-term – Funding required (Approach Audrey Delsink as a matter of urgency).
Culling	Unpalatable but necessary?	Immediate

The first option is that the various game populations are allowed to fluctuate with the prevailing conditions, i.e. a die-off in drought (weaker animals). The tricky issue if the latter option is pursued is the effect on the resources (particularly grazing) resulting from such a 'laisse-faire' approach. Ultimately some debate would need to be entered into in this regard to gauge the feeling of the land owners and adjacent neighbours (KNP) in consultation with the managers/ecologists working on the reserve. Where a hands-off management approach is taken the **decision would**

be to not control numbers outside of the relatively small hunting quota. We do not believe that this is an option given that the problem is largely man-induced (water provision …).

However, management of species at risk such as white rhino is critical – we cannot afford to lose rhino through drought. Dispersive ‘culling’ of elephant may be an option as described above. Further, droughts are times when the lion population takes advantage of the weakened condition of species like buffalo. By removing large numbers of buffalo, lions may target some relatively vulnerable prey species such as wildebeest, zebra and waterbuck. The latter should not be managed as the lion population has the ability to relatively quickly push them into a predator pit. This is not to say there will not be die-offs within these populations. All the while the grazing resource will be stressed.

The second option is to take positive action and to reduce selected herbivore populations as rapidly as possible. These populations would be elephant and impala – both mixed feeders and buffalo, white rhino and hippo – all grazers.

We propose an adaptive management approach where opportunities are grasped (allow numbers to climb) and hazards are avoided (large scale die-offs related to veld degradation). Under the current circumstances we therefore propose a closely monitored adaptive management approach where in 2016 the APNR implements large scale management interventions in the interests of habitat conservation and in particular reducing the risk of rhino dying of starvation.

PROMPT ACTION IS CRITICAL TO SUCCESS.

The sooner game removals take place the better. However, there are three potentially negative factors that can be mitigated by prompt action on the part of the APNR staff and the relevant conservation authorities (SANParks, Limpopo and Mpumalanga). The sooner the large scale removals are effected, the lower risk of any of the following factors impacting on the programme and the lower the risk of avoidable mortalities. These factors are:

- As the dry season progresses, animals will inevitably lose condition as food availability and quality declines. The greater the loss in physical condition, the greater the risk of mortalities during capture and especially transport. Therefore from an animal welfare point of view, it will be better to remove the animals immediately (with the possibility of removing more in the case of emergency after May;
- The APNR lies within an area known for recurrent outbreaks of anthrax. As waterholes dry up and the underlying mud is exposed, so are anthrax spores and the risk of an outbreak occurring increases. If an outbreak does occur, the risk is high that the movement of live animals from the APNR will be prevented by the Department of Veterinary Services. To reduce the risk of this happening, removals should be done before water points dry out and risk of an anthrax outbreak is still low.
- The longer the animal numbers destined for removal remain on the veld, the greater the impact of their grazing and browsing will be. The sooner they are removed, the quicker the reduction in herbivore pressure and the more food that will be available for the remaining populations. This will also take pressure off the veld and allow for a more rapid recovery when favourable seasons return.

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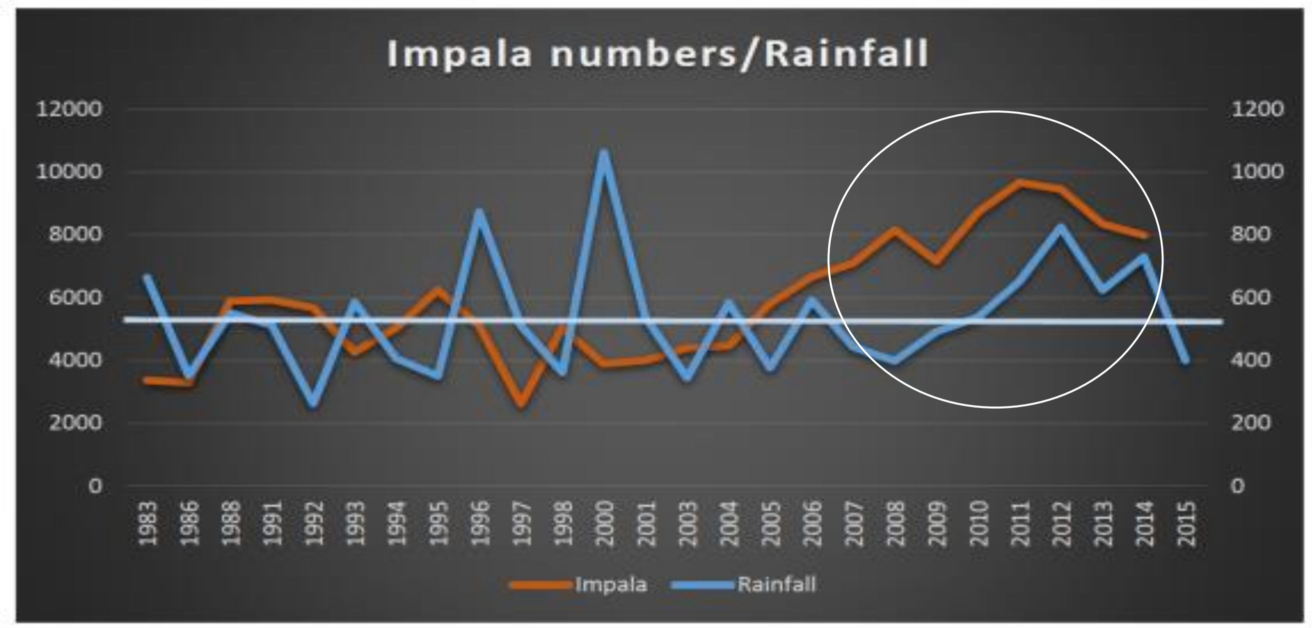
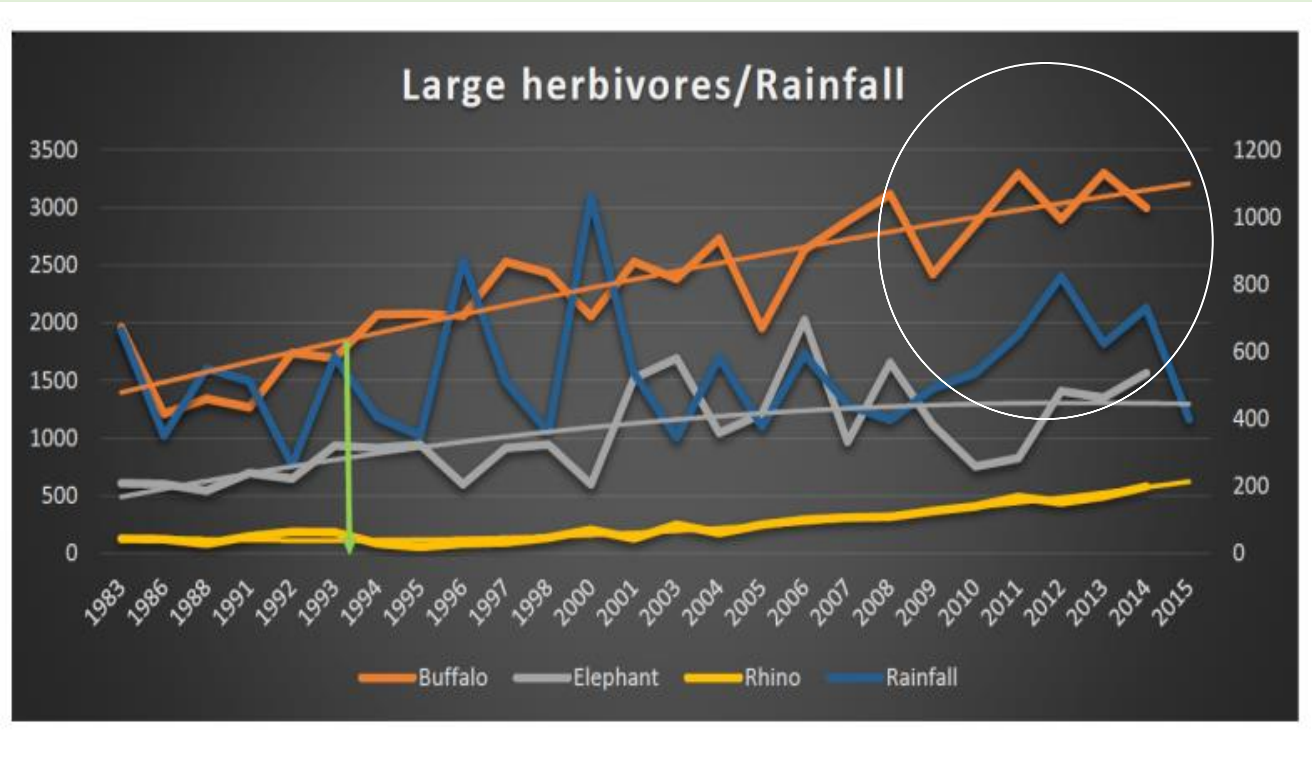
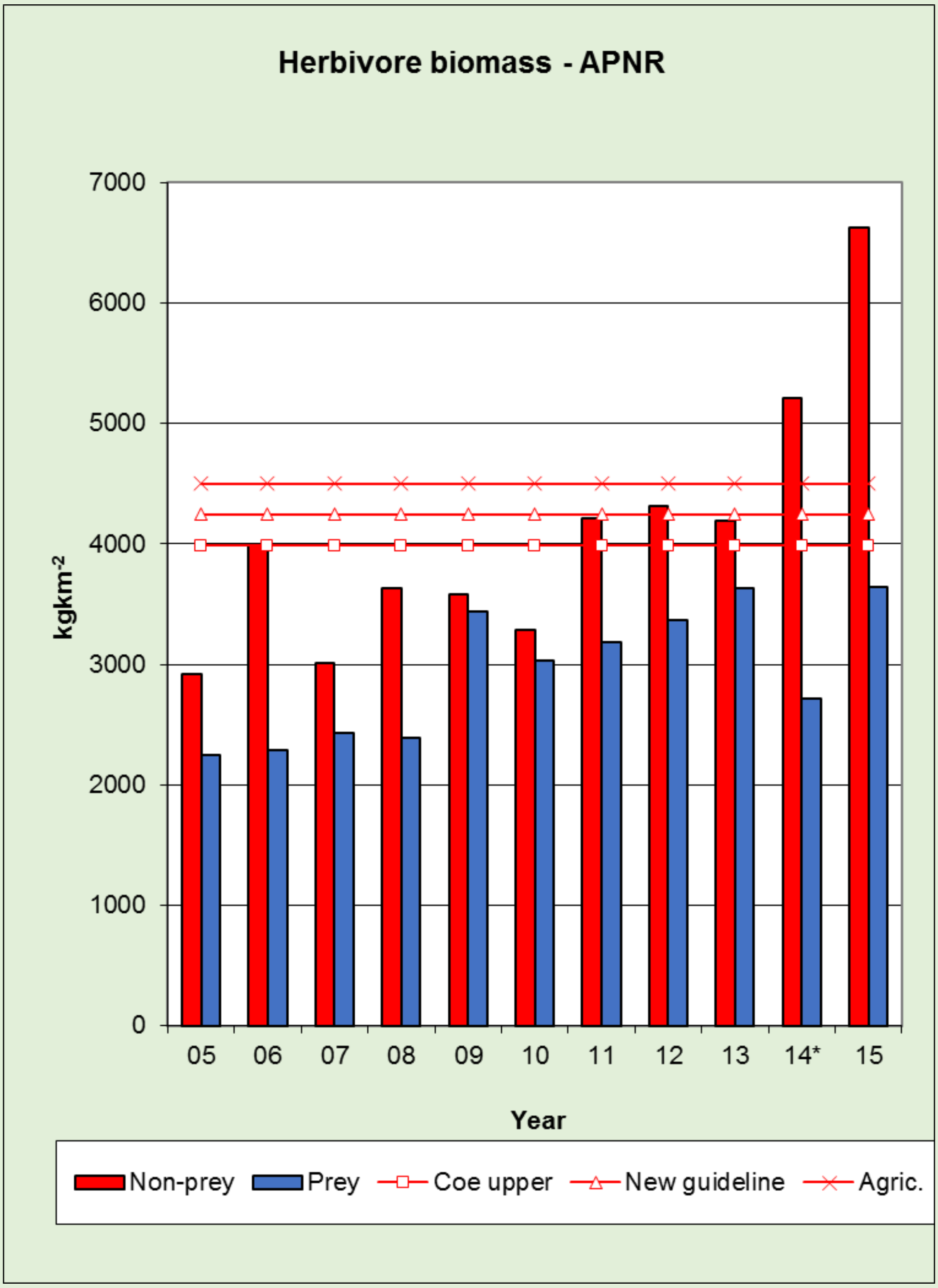
Appendix showing increase in impala and buffalo in particular with rainfall (circled area) and to a lesser extent elephant (Jeremy Anderson out of Jacques Brits report).

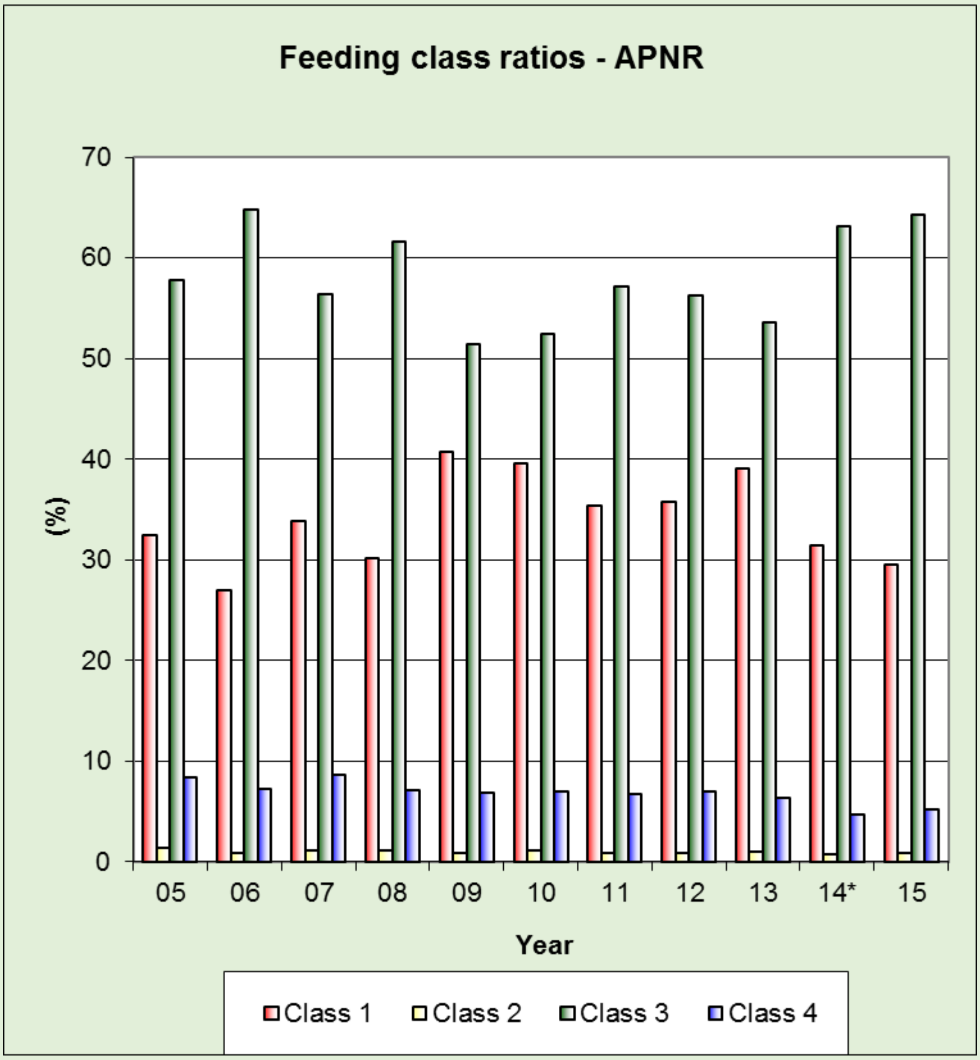




Appendix showing increase stocking densities in the APNR (Peel report 2015 *in prep.*).



Appendix showing skewed feeding class proportions in the APNR (Peel report 2015 *in prep.*). Note Class 3 mixed feeders (elephant and impala) dominate the biomass (64%); class 1 bulk grazers (buffalo, hippo, rhino – 30%), class2 selective feeders (wildebeest and warthog 0.9%) and class 4 feeders - browsers (5%).



Appendix B

Lowveld Protected Areas: To Manage or Not to Manage

Mike Peel (Agricultural Research Council, Rangeland Ecology Group – mikep@arc.agric.za)

As we are all aware, the Lowveld has experienced average to above average rainfall over the past six years. During these 'years of plenty', with the veld looking great we are often numbed into a false sense of security and as game numbers increase, we try to create a sense of 'anticipatory awareness' – the dry times will return and we cannot predict when, how long and what the severity of the dry period will be when it comes. In fact it appears that with increased variability in climatic conditions, prediction may become more and more difficult.

The Rangeland Ecology group of the Agricultural Research Council has over many years presented potential animal trend scenarios to a large number of land users based on current veld condition and animal numbers (both based on up to 25 years of historical data) under varying rainfall conditions and with the predicted response of the grass layer to these variables. The bottom line is that we do not want unpleasant surprises and we need to be proactive rather than reactive when taking management decisions relating to animal numbers. In the following discussion I share some thoughts relating to animal management under fluctuating environmental conditions.

The fact that, due to land fragmentation there is no longer movement to the higher rainfall areas and forage resources in the west near the Drakensberg range means that there will be animal losses in drought years. Population declines especially in larger grazer species such as buffalo, zebra and wildebeest would vary from minimal through sharp as evidenced by the 1982-83 drought for example where some grazers were reduced to between 10 and 20% of their pre-drought numbers following large scale perennial grass mortality. Mortality amongst these grazing herbivores may be viewed as part of a longer term cycle and droughts are also times when predators, in particular lions, feast on weakened animals.

The question is whether or not we are prepared to allow drought related mortality to occur and whether the cost to the veld would be acceptable if numbers are allowed to increase unchecked? Management decisions are also linked to whether the protected area is fenced (no movement to favourable grazing areas possible) or not.

The relationship between grass production and standing crop is highlighted with recent favourable rainfall seasons in the eastern Lowveld (mean or above rainfall since 2008/09 in the example given below) resulting in an increase in grass standing crop (the portion of production that remains after utilisation) (Figure 1). The latter is due to a favourable perennial composition and cover and improved soil moisture conditions that promote grass growth (Figure 1). This has in turn resulted in a steady increase in herbivore numbers in Lowveld Protected Areas (Figure 2) which largely reflects these favourable grazing conditions.

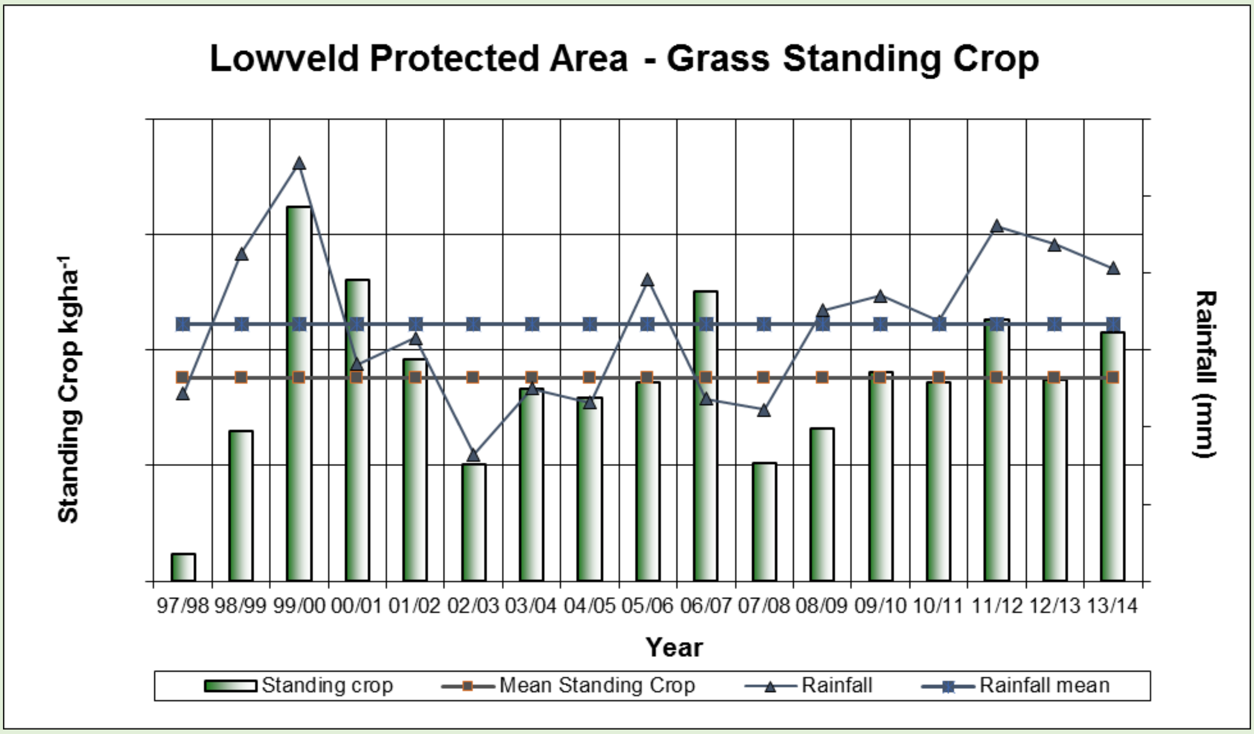


Figure 1 illustrating the favourable relationship between annual rainfall and grass standing crop (note mean or above mean rainfall since 2008/09 and above or above average grass standing crop since 2009/10 – note lag of one rainfall season before the grass response becomes clearly evident.

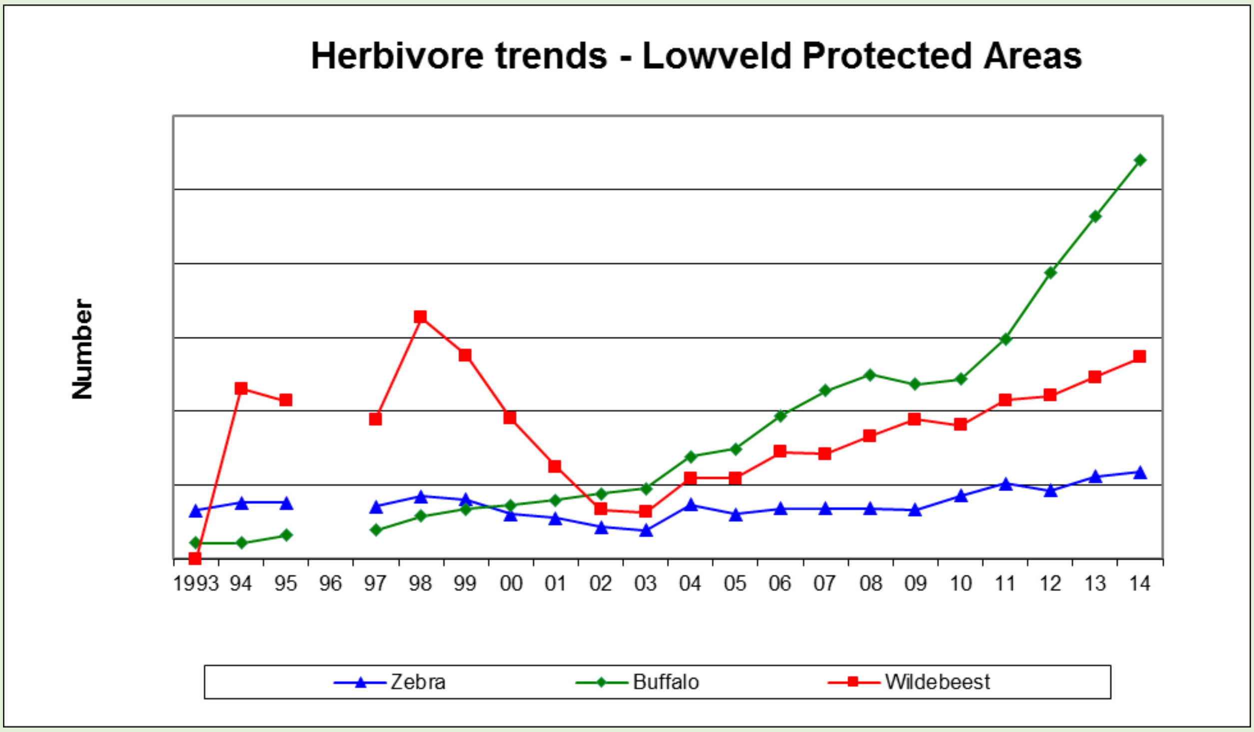


Figure 2 illustrating trends in three grazing species in the protected areas of the eastern Lowveld. Note the increases in these important grazers in response to the data shown in Figure 1 (increased rainfall and increased grass standing crop from around 2008/09 and linked increases in grazing animals)

Over the past few years we can see that the grass layer has not been limiting for grazers in general (Figure 1). Further I think that given the fact that grazers like buffalo move in large herds over extensive areas and are not sedentary around a single water point, that they have a generally beneficial effect on the vegetation for, among others, the following reasons. High densities of large hooved animals:

- Break soil crusts by their hoof action allowing for a good soil surface to seed contact;
- Reduce the height of moribund grass, thus allowing sunlight to penetrate the shorter vigorous grass tufts while reducing the temperature of the soil and making it more suitable for rainfall infiltration; and
- Deposit concentrated amounts of dung and urine.

All of the above promotes seedling establishment, particularly in bare areas and promotes a healthy productive perennial sward of grasses. Closer plant spacing (increased density) with a better litter layer (organic matter) and stable soils results in less evaporation and more effective rainfall (infiltration) with lower soil temperatures, less rainfall runoff, silting up of streams etc. The presence of predators, in particular lions, causes buffalo herds to bunch when chased thus intensifying the positive impacts outlined above.

The fact that these large herds are mobile also means that they seldom 'camp' on a patch for a long period of time but are continually moving through different landscapes. This means that unlike selective water dependent grazers, buffalo will utilise an area and then move on thus reducing the chance of overgrazing (a function of time and not necessarily number – veld needs rest). For example excessive artificially supplied surface water results in high densities of sedentary water dependent species (e.g. impala). So where and when do we exercise animal control? Even on unfenced areas animal control may need to be considered where water point provision has resulted in increased animal numbers due to their increased distribution resulting in insufficient forage for animals during dry periods (obviously more critical in fenced situations). The alternative is that the population is allowed to fluctuate with the prevailing resource conditions, i.e. a die-off in drought (weaker animals). This may be acceptable in unfenced, 'open' situations but is it appropriate in fenced areas where animals are unable to migrate? The tricky issue if the 'laisser-faire' option is pursued, is the long term effect on the resources resulting from overgrazing

A hypothetical example from a fenced area – to manage or not to manage

We examine the effect of resource use by grazers by inserting the resource requirements for grazing species and determine whether the grazing population is able to maintain themselves under varying environmental and attendant resource conditions.

For this exercise the model is based on a fenced protected area using real data (main grazers rounded off: buffalo 1 000; wildebeest 550; zebra 250; impala 3 100), year 1 grass standing crop (≈ 1 700kg ha^{-1} which provides some residual for the year 2 season's standing crop) and as a worst case scenario a projected a grass standing crop for year 2 season which yields only 600kg ha^{-1} (approximately the lowest standing crop on the PA in question for some 18 years). The results indicate that there would have been insufficient forage for the grazing animals present on the PA. This information is critical for managers to take early animal management decisions and depending on the amount of risk they are willing to take. Any animal management would be aimed at preventing:

- Excessive animal die-off; and

- Veld degradation.

This situation obviously brings into question the species that we should consider managing. We need to be wary about reducing prey species such as wildebeest and zebra which, in this case are showing encouraging increases (Figure 2). The reason for this caution is that the lion population has the ability to relatively quickly push these and other more sensitive species (e.g. waterbuck) into a predator pit (as happened under high predator levels for wildebeest and zebra between 1997 and 2002 (Figure 2). The latter situation required predator, in particular lion, management – a discussion for another day!). Consideration could be given to the removal of species such as impala but caution is again advised as impala are an important buffer to other prey populations that may be under pressure. All the while the grazing resource would be stressed. To address this situation the removal of around 20 buffalo would have ensured that there was just sufficient food to satisfy the needs of the grazing population (this is obviously an oversimplification but is used here purely for illustrative purposes).

The reality is that we had a good year 2 season so the stressed grazing situation never materialised. If we feed the year 2 standing crop in (≈ 2 100kgha^{-1}) and project an increase in animal numbers minus predation (actual data obtained from the protected area concerned) and remembering that populations close to 'ecological carrying capacity' do not generally increase at rates attained when a population is increasing with surplus resources (on the fast part – logarithmic part of the growth curve) then anything less than 680kgha^{-1} would result in a shortage of grazing. Note: The point at which grazing stress becomes an issue increases from 600kgha^{-1} to 680kgha^{-1} (assuming reduced animal increment levels for the reasons given above resulting in more grass but still a stressed grazing resource to 'break-even). At 600kgha^{-1} it would be difficult to reduce the number of buffalo alone (in one exercise) to get to the 'break even' point as this number would be projected at around 1 150 to reduce to around 900 (a 10% increase in buffalo from 1 000 is 100! Plus the other species would also increase in number). Is this logistically practical? We need to look at other species as well. In addition, for example, 700 impala could be removed to stabilize the situation. As stated above however we need to be wary to reduce prey species such as wildebeest and zebra (which are both increasing), as well as waterbuck due to their susceptibility to heavy predation.

BUT the above assumes a drought situation and we are coming off a run of good seasons. The good news is there was sufficient grazing and offtakes should be aimed at maintaining this situation depending on rainfall. A staggered offtake is logistically preferable but what I aim to illustrate in this discussion is how quickly ‘things can get away’. On fenced areas where the animals cannot move the situation is even more critical!!

An active adaptive management approach means that in the worst case scenario:

- We suffer a drought
- We lose animals;
- Pressure is taken off the veld;
- Feeding is considered in some instances;
- We recoup something from offtakes.

The best case scenario would be that;

- We do not suffer a drought
- We lose animals through natural attrition
- Pressure is taken off the veld;
- The veld remains in a favourable condition;
- We recoup something from offtakes.

In unfenced protected areas there is obviously another option in terms of management, that of a laisser faire or hands-off approach. However, populations cannot increase at consistent rates under stressed conditions so one would expect a drop off in natural increments. So we use adaptive management where opportunities are grasped (allow numbers to climb) and hazards are avoided (large scale die-offs related to veld degradation).

In many Lowveld protected areas the stocking rates are such that it would require a relatively large management effort to reduce the numbers to adapt to any decline in veld condition. As the grazing resource is generally limiting, grazer species in particular require constant monitoring (removal, feeding or no action). These ‘managed’ animals would be animals not removed by predation but considered necessary for removal for ecological reasons while at the same time being careful not to push prey species into a ‘predator pit’ and all the while striving to achieve the ecological and economic objectives of the protected area in question.

Appendix C

Numbers of larger animals obtained from the 2016 helicopter count – APNR (excluding Kempiana – red text indicates that Balule did not count these species). In 2014 BNR counted with a different helicopter and team and only rhino, elephant, hippo and buffalo were counted in that reserve. The 2013 figures for BNR for the species not counted are included in brackets below the APNR totals for 2014 to provide some context of trend. *2010 top Brits figure, bottom count number; 2011 buffalo and elephant counts APNR used. 2017 includes Thornybush, and the properties Maseke, Amsterdam and Excellence.

Species	Total										
	2007	2008	2009	2010*	2011	2012	2013	2014	2015	2016	2017
Black rhino				- 3	8	11	17	4	19	11	31
Blue wildebeest	443	539	532	504 504	447	477	556	460 (193)	769	814	1 235
Buffalo	4 067	3 912	7 121	6 036 4 661	6 123	6 411	7 358	5 633	7 291	5 494	2 327
Bushbuck	120	53	63	- 52	74	76	85	33 (52)	136	79	89
Elephant	1 178	1 566	1 388	1 254 1 226	1 651	1 666	1 634	2 100	2 772	2 630	2 224
Giraffe	732	666	786	679 681	752	800	713	568 (254)	816	892	1 055
Hippo	165	222	247	256 259	251	306	314	308	314	303	266
Impala	20 697	22 745	24 851	24 667 24 692	26 904	29 441	30 626	22 491 (8 718)	30 289	26 400	35 044
Kudu	1 428	1 396	1 300	1 375 1 365	1 640	1 783	1 960	1 291 (828)	1 855	1 812	2 350
Nyala	73	42	63	23 62	52	112	98	56 (39)	107	91	549
Warthog	709	596	579	868 863	901	1 159	1 122	774 (437)	919	772	932
Waterbuck	760	681	837	736 739	846	877	1 099	476 (675)	977	685	839
White rhino	306	295	375	363 359	433	452	486	521	503	398	357
Zebra	1 131	1 207	1 242	953 953	1 076	985	1 233	961 (448)	1 205	1 263	1 622

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Appendix D

Correspondence relating to the hunting quota for the APNR for 2018.

09/12/17

Dear Craig

GAME REMOVALS 2018: APNR v6

Our meetings of 25 October, 8 November, my meeting with Petri Viljoen on 17 November and your correspondence including the final Klaserie offtakes (email 21/11/17) and Timbavati (email 28/11/17 and 06/12/17) and UPNR (07/12/17) refers. The 2017 game count numbers were used to calculate stocking rates, feeding class ratios and to examine herbivore trends with a view to determining sustainable offtakes for the various reserves within the APNR while also taking into account the current state of the rangelands. Note the following:

2. Comments on the proposed management/hunting removals based on the 2017 count;
3. My annual report will contain projections forward and take the possible effect of predators into account where possible (I await estimates from the various reserves);
4. As stated in my correspondence regarding demographic studies within the APNR the following. The reserves comprising the APNR are taking steps to collect demographic data to ensure that offtakes within the elephant and buffalo populations in particular are sustainable (Peel 2013 and APNR Wardens *pers. comm*. and discussed at this years' meetings). In this regard I again commend the actions that all concerned put into the protocols;
5. The taking of minutes at the meeting is critical as it allows anyone who has queries to go through the discussion and processes that were followed regarding the final offtake decisions.

In addition to the fact that the system is 'open', the influence of favourable/drought rainfall years on the vegetation has implications for, among others: fire, herbivore dynamics and interactions, predator-prey relations, counting conditions and ultimately game numbers. In addition to the data collected by management, much information exists within the current landowner and lodge structure (e.g. predation data, sex and age data…).

The APNR summary (attached below) is again a well-considered document although missing some detail around protocols. I have looked at the offtake proposals and largely support them with some discussion included. As stated in previous reports I agree that **large-scale** (possible) removal of impala be done for ecological and economic reasons. We are seeing that the lion population is benefiting from a weakened buffalo population. The 2017 count again illustrates that other ‘prey’ herbivores are relatively finely balanced with the predator, in particular the lion, population. See further comments in the table below.

There has been much discussion around the management of white rhino and I include excerpts of text from a document written by myself and Jeremy Anderson (GRAZING SITUATION AND OFFTAKES 2016: APNR - v1 26/01/16 and v7 12/03/16). To summarise, we stated that existing high herbivore densities result in increased competition with white rhino and possible related mortalities. At that stage it was already evident that species such as buffalo were starting to compete with white rhino. We could not afford to lose rhino to drought and poaching and so we proposed an adaptive management approach where opportunities are grasped (utilize/tranbslocate animals in this case) and hazards are avoided (large scale die-offs related to veld degradation). Given the drought conditions we therefore proposed a closely monitored adaptive management approach where the APNR would implements large scale management interventions in the interests of habitat conservation and in reducing the risk of rhino dying of starvation. Among other relatively heavy offtake recommendations, we proposed the relocation of up to 100 white rhino (and possibly more) to an area with surplus grazing and this received favourable consideration by the APNR board and management. The action did not materialise but taking the above into consideration, the 2018 offtakes (also from Petri Viljoen’s model – scenario C) are supported especially that given the right conditions white rhino is a highly successful breeder. The TB situation within the white rhino population has reduced the opportunity to move these animals.

We also proposed in the abovementioned document that, given the drought, private protected areas contribute animals to communal areas for non-consumptive and consumptive use as a way to encourage the ‘wildlife economy’ in these important rangelands. We feel that an excellent opportunity was missed in this regard and that we should be prepared to exercise such options in the future.

I continue to enjoy the collaboration on ecological issues between the various wardens, researchers and staff of the management authorities in the area. Please do not hesitate to contact me if there are any queries.

Yours Sincerely

(DR. MIKE PEEL: Pr.Sci.Nat; M.G.S.S.A - SPECIALIST SCIENTIST RANGELAND ECOLOGY)
COPY: CRAIG SPENCER TO CIRCULATE AS REQUIRED; DR PETRI VILJOEN; DR J. TJELELE

Count totals for the APNR Reserves (with the addition of Excellence, Amsterdam, Maseke and Thornybush) for 2017 (with APNR totals for 2015 and 2016 for ease of reference).

	KPNR	**TPNR**	**Thorny bush**	**UPNR**	**BPNR**	**APNR 2017**	**APNR 16**	**APNR 15**
Buffalo	601	1 106	166	272	282	**2 327**	**5 494**	**7 291**
Elephant	548	465	349	141	721	**2 224**	**2 630**	**2 772**
Hippo	71	67	17	5	106	**266**	**303**	**314**
White Rhino	139	151	13	7	47	**357**	**398**	**503**
Giraffe	312	307	100	15	321	**1 055**	**892**	**816**
Impala	13 032	5 844	3 685	2 558	9 925	**35 044**	**26 400**	**30 289**
Kudu	708	417	256	153	816	**2 350**	**1 812**	**1 855**
Waterbuck	151	237	8	1	442	**839**	**685**	**977**
Blue Wildebeest	240	561	312	6	116	**1 235**	**814**	**769**
Zebra	443	626	185	72	296	**1 622**	**1 263**	**1 205**
Warthog	262	152	161	38	319	**932**	**772**	**919**
Bushbuck	9	1	15	0	64	**89**	**79**	**136**
Nyala	33	25	438	15	53	**549**	**91**	**107**

Proposed Total APNR off-takes for 2018

Species	**Count APNR / Count class**	**Offtake Proposal Total and as a % of reserve total (in columns) (✓-acceptable; ✓ - but requires further study/extenuating circumstances; x - high)**				**% of APNR population (✓; ✓; x)**
Buffalo	**2 327**	KPNR	TPNR	UPNR	BNR including Excellence	
Management <34"	36	8 – 1,33✓	10 – 0,90✓	**17 – 6,25x**	1 – 0,35✓	1,48✓
Classic bulls > 12y	7	2 – 0,33✓	4 – 0.36✓	1 – 0,37✓	0	0,29✓
Cows commercial >12y	12	12 – 2,00✓	0	0	0	0,49✓
Cows non-commercial >12y	3	0	3 – 0,27✓	0	0	0,12✓
Total offtake	♂ 43 ♀ 15 – All 58	***10 – 1,66✓** 12 – 2,0✓ 22 – 3,66✓	***14 – 1,26✓** 3 – 0,27✓ 17 – 1,53✓	***18 – 6,62x** 0 18 – 6,62✓	***1 – 0,35✓** 0 – 0,0✓ 1 – 0,35✓	***1,84✓** 0,65✓ 2,39✓
Comments Buffalo	**High for UPNR management bulls <34".** Within guideline for ♂ and ♀ and combined for: APNR overall, KPNR, TPNR, and BNR. UPNR excessive. ***In the future, we need to have the results of the demographic studies in time to determine the sustainability of current offtake rates.**					
Elephant	**2 224**	KPNR	TPNR	UPNR	BNR	
Bulls<30lbs	35	5 – 0,91✓	**7 – 1,51x**	**4 – 2,84x**	**19 – 2,64x**	**1,57x**
Bulls<40lbs	17	4 – 0,73✓	4 – 0,86✓	**4 – 2,84x**	5 – 0,69✓	0,76✓
>50y	1	0	0	1 – 0,71✓	0	0,04✓
Total offtake	53	**9 – 1,64x**	**11 – 2,37x**	**9 – 6,38x**	**24 – 3,33x**	**2,38x***
Comments elephant	A guideline to maximum percent of the total for sport hunted elephant is 0.75 - 1% which is exceeded if we look at: KPNR, TPNR, UPNR, BNR and APNR overall. Question - what do we define as sport hunt a trophy animal or are these categories in the 'management' class but hunted commercially? ***The elephant population makes up 60% of the total herbivore biomass of the APNR and we consider the offtakes sustainable.** While the hunting programme is not aimed at population control this will contribute in some way to reducing numbers. At the same time hunting in areas targeted by elephant may be a useful learning tool to see if this type of exercise in fact will disperse elephant out of sensitive areas. As previously stated this is a guideline requiring verification and data collection as per the buffalo demographics study. Bulls make up the following proportions in the reserves for which there are data: KPNR 3%, TPNR 7% (8% previous), UPNR 21% (18% previous) and BNR 17% (17% last year).					

Species	Count APNR / Count class	Offtake Proposal Total and as a % of reserve total (in columns) (✓-acceptable; ✓ - but requires further study/extenuating circumstances; x - high)				% of APNR population (✓; ✓; x)
White Rhino	**357**	KPNR	TPNR	UPNR	BNR including Excellence*	
Commercial hunt bulls	0	0	0	0	0	0.0
Live sales cow/calf combinations	3	0	3 – 1,99✓	0	0	0,84✓
Live bull sales	0	0	0	0	0	0
Total offtake	3	0	3 – 1,99✓	0	0	0.84✓
	The largely conservation directed effort for white rhino removals is supported and a larger number could be considered (further supported because of the extended drought. We cannot afford to lose rhino to poaching and drought). The hunting request is ecologically acceptable.					
Hippo	**266**	KPNR	TPNR	UPNR	BNR including Excellence*	
Hippo bulls commercial hunt	7	3 - 4,23✓	2 – 2,99✓	0	2 – 1,89✓	2,63✓
Live sales		0	0	0	0	0
Total offtake		3 – 4,23✓	2 – 2,99✓	0	2 – 1,89✓	2,63✓
	The quota is sustainable for the APNR overall, again supported because of the extended drought. The hunting request is ecologically acceptable.					
Impala	**35 044**	KPNR	TPNR	UPNR	BNR including Excellence*	
Landowner consumptive and culling	4 171	1 000 – 7,67✓	1 000 – 17,11✓	336 – 13,14✓	1 535 – 15,47✓	11,90✓
Total offtake		✓	✓	✓	✓	✓
	We are in the grips of a serious drought and I believe the proposed removals are acceptable. Impala are water dependent non-mobile species and at high densities impact heavily on rangelands. This does not ignore their function as a buffer to vulnerable species such as giraffe, wildebeest, zebra etc. the latter notwithstanding a larger number of impala could sustainably be removed. On the other hand it is apparent that the lion are targeting the weakened buffalo population. The removal of 300 impala from Thornybush Game Reserve is sustainable.					
Waterbuck	**839**	KPNR	TPNR	UPNR	BNR including Excellence*	
Trophy bull commercial hunt	3	0	1 – 0,42✓	0	2 – 0,45✓	0,36✓
Bull non-commercial hunt	8	0	0	0	8 – 1,81✓	0,95✓
Total offtake	11	0	1 – 0,42✓	0	10 – 2,26	1,31✓
	Acceptable. A demographic study of waterbuck is necessary to					

Species	Count APNR / Count class	Offtake Proposal Total and as a % of reserve total (in columns) (✓-acceptable; ✓ - but requires further study/extenuating circumstances; x - high)				% of APNR population (✓; ✓; x)
	assess the sustainability of the bull animals in the future.					
Kudu	**2 350**	KPNR	TPNR	UPNR	BNR including Excellence*	
Kudu bulls commercial	6	2 – 0,28✓	1 – 0,24✓	1 – 0,65✓	2 – 0,25✓	0,26✓
Kudu bulls non-commercial	22	5 – 0,71✓	0	4 – 2,611✓	13 – 0,59✓	0,94✓
Cows non-commercial	22	5 – 0,71✓	4 – 0,96✓	0	13 – 1,59	0,94✓
Total offtake	50	12 – 1,69✓	5 – 1,2✓	5 – 3,27✓	28 – 3,43✓	2,13✓
	Acceptable.					
Warthog	**932**	KPNR	TPNR	UPNR	BNR including Excellence*	
Commercial	3	0	1 – 0,66✓	0	2 – 0,63✓	0,32✓
Non-commercial	19	7 – 2,67✓	0	0	12 – 3,76✓	2,04✓
Total offtake	22	7 – 2,67✓	1 – 0,66✓	0	14 – 4,39✓	2,36✓
	Acceptable. Can increase as these animals will die during the drought. Also an important prey species however.					
Giraffe	**1 055**	KPNR	TPNR	UPNR	BNR including Excellence*	
Commercial	**5**	0	3 – 0,98✓	0	2 – 0,62✓	0,47✓
Total offtake	**5**	0	3 – 0,98✓	0	2 – 0,62✓	0,47✓
	Acceptable					
Zebra	**1 622**	KPNR	TPNR	UPNR	BNR including Excellence*	
Commercial	**3**	0	3 – 0,48✓	0	0	0,18✓
Non-commercial	**3**	3 – 0,68✓	0	0	0	0,18✓
Total offtake	**6**	3 – 0,68✓	3 – 0,48✓	0	0	0,36✓
	Acceptable					
Wildebeest	**1 235**	KPNR	TPNR	UPNR	BNR including Excellence*	
Commercial	3	0	3 – 1,25✓	0	0	0,24✓
Total offtake	3	0	3 – 1,25✓	0	0	0,24✓
	Acceptable					
Bushbuck	**89**	KPNR	TPNR	UPNR	BNR including Excellence*	
Commercial	2	0	0	0	2 – 3,13✓	0,16✓
Total offtake	2	0	0	0	2 – 3,13✓	0,16✓

Species	Count APNR / Count class	Offtake Proposal Total and as a % of reserve total (in columns) (✓-acceptable; ✓ - but requires further study/extenuating circumstances; x - high)				% of APNR population (✓; ✓; x)
	Acceptable					
Nyala	**549**	KPNR	TPNR	UPNR	BNR including Excellence*	
Bulls commercial	**2**	2 – 6,06✓	0	0	0	0,36✓
	2	2 – 6,06✓	0	0	0	0,36✓
	Acceptable					
Lion		KPNR	TPNR	UPNR	BNR including Excellence*	
Male	**2**	0	0	1	0	✓
Total offtake		KPNR	TPNR	UPNR	BNR including Excellence*	
	Acceptable. A demographic study of predators would be useful to assess the sustainability of the requested trophy animals in the long term.					
Leopard	**1**	0	**0**	1x	0	x
Male	**1**	0	**0**	1x	0	x
	Not sure why TPNR requested 1 animal – moratorium on leopard – suggest remove from request					
	Moratorium on leopard hunting					
Hyena	**5**	0	5	3	0	✓
	5	0	**5**	3	0	✓
	Ecologically sustainable – target animals critical to ensure minimal disruption of clan structure. Does APNR meet SANParks protocol requirements?					

Baboons 5 and Vervet monkeys 5 – approve.

Appendix A

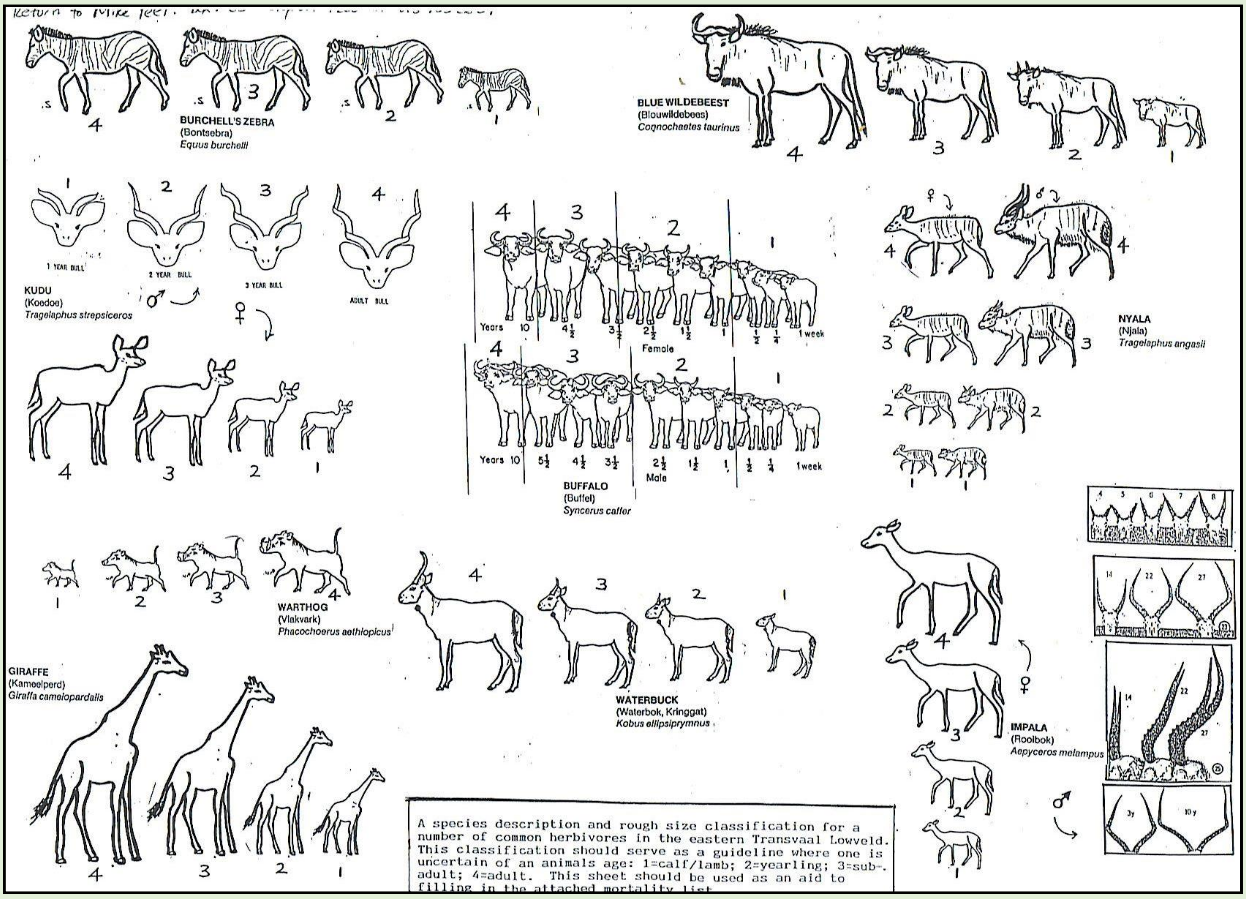
Correspondence for the proposed offtakes for the APNR for 2018 received from Craig Spencer and adjusted as per Table above “**Proposed Total APNR off-takes for 2018**”.

2018/2019	Klaserie		Timbavati		Balule		Excellence		Umbabat		Brazilie		Littig		Thornybush		Total		
	Commercial	Non-comercial	Commercial	Non-commercial	Commercial	Non-comercial	Commercial	Non-commercial	Commercial	Non-commercial	Commercial	Non-commercial	Commercial	Non-comercial	Commercial	Non-commercial	Commercial	Non-comercial	
BUFFALO management <34"	10		10				1		12		3		2				38		
CLASSIC BUFFALO BULLS >12 years old			4										1				5		58
BUFFALO COWS >12 years old	12			3													12	3	
ELEPHANT Bulls <30 lbs	5		7		18		1		3				1				35		
ELEPHANT Bulls <40 lbs	4		3		5				3				1				16		53
ELEPHANT >50 yrs			1						1								2		
KUDU Bulls		7		2		13	2			4	1						3	26	56
Kudu Cows	5	5		4		13											5	22	
Nyala bulls		2																2	
IMPALA		1002		1000		1500	35			300		24		12		300	35	4138	4173
WARTHOG		7		2		12	2										2	21	23
WATERBUCK				2		8	2										2	10	12
HIPPO LETHAL HUNT	3		2				2										7		
WHITE RHINO LIVE CAPTURE - COW + CALF COMBO.			3														3		4
WHITE RHINO LETHAL HUNT			1														1		
LION			1						1								2		
HYENA			5								1		2				8		
LEOPARD			1						1								2		
GIRAFFE bulls			3				2										5		
ZEBRA		3		3														6	
WILDEBEEST				3														3	
Bush Buck Ram							2											2	
Baboons							5										5		
Vervet Monkeys							5										5		

Appendix E

Sex and age structures of herbivores on APNR reserves (use attached sheet to assist with sex/age classification-PTO)

Date	Species	Number	Age class/sex								Location/GPS
			1		2		3		4		
			M	F	M	F	M	F	M	F	



Guide to assessing age in various game animals for use in age classification (previous page).