Aerial Survey of Etosha National Park.

Internal Report to the Ministry of Environment and Tourism.

by

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September 2015.

CONTENT

1. INTRODUCTION.

Aerial stratified sample counts have been conducted since 1995 in Etosha. The 2015 aerial count of Etosha was conducted from 4 September till 21 September. Including the latter survey, a total of eight comparable multi-species counts have been completed since 1995.

The objectives of the 2015 count followed those of the 2012 count and were:

1.1 to provide comparable estimates and trend data for key species in support of species and park management,

1.2 to obtain a population estimate for elephants in line with the MIKE program and in support of CITES,

1.3 to update the population estimate of black rhino in support of the National strategy for the species,

1.4 Additionally, the survey provides a comparable population estimate for black rhino with the specialized helicopter block count.

1.5 The fixed-wing surveys and helicopter block counts can also be applied to provide various levels of data in support of rhino security in Etosha.

1.6 Due to the security situation in Etosha, the Black rhinoceros survey data are not reflected in this report.

2. SURVEY DESIGN AND METHODOLOGY.

2.1 Sampling.

The survey zone was 18 551 km^2 in extent, and covered the entire Etosha Park excluding the main pan. Similar to past surveys, the area was stratified (Figure 1) according to the expected distribution of wildlife in the dry season. All areas within 10 kilometers of perennial watering points were sampled at an intensity of 40%. The sampling intensity of blocks 8 and 9 was set at 20% due to lower numbers of animals in these areas. For this survey, it was decided to reduce the sampling intensity for block 6 to 20% due to low game numbers.

At a designed strip width of 500 meters at 300 feet above ground level, the transect spacing was 1.25 km for 40% intensity, 2.5 km for 20% intensity and 5 km for 10% intensity. All transects were orientated in a northerly direction, except block 10 (east-west transects and block 14 (north-west).

Areas surveyed and actual flight paths flown are presented in Figure 2.

2.2 Calibration.

Only two observers were used in the entire survey. Calibration of the observers was done at the Okaukuejo airfield according to standardized methodology. The calibrated strip widths were calculated for each observer, and demarcated in the correct positions on each wing strut.

2.3 Cockpit management.

The plane was equipped with 2 GARMIN 12 XL GPS's. The recorder uploaded the flight paths onto the GPS's, which ensured accurate navigation by means of a moving map. The recorder logged and took GPS positions of all animal observations from the left and right observers, recorded the aircraft height above ground level at regular intervals for each transect, which allowed for the calculation of the average height for each block. One data sheet was used per transect flown.

2.4 Data management.

At the end of the day's flying, the raw datasheets were filed, track files and waypoints were downloaded and backups made. OziExplorer software was used to up and download waypoint and route files. ArcGIS was used to plot distribution maps of animal distributions. The data in digital format and the original data files are kept at the Etosha Ecological Institute.

2.5 Analysis.

Jolly's Method number 2 for unequel -sized sampling blocks was applied to the data. All data analyses were done in an Excel spreadsheet.

2.5 Aircraft and crew.

Only one team conducted the survey using a Cessna 182 (V5-ISE), which belong to the Ministry of Environment and Tourism. All crew members were highly experienced in flying and counting procedures, which contributed to a reduction in observer bias.

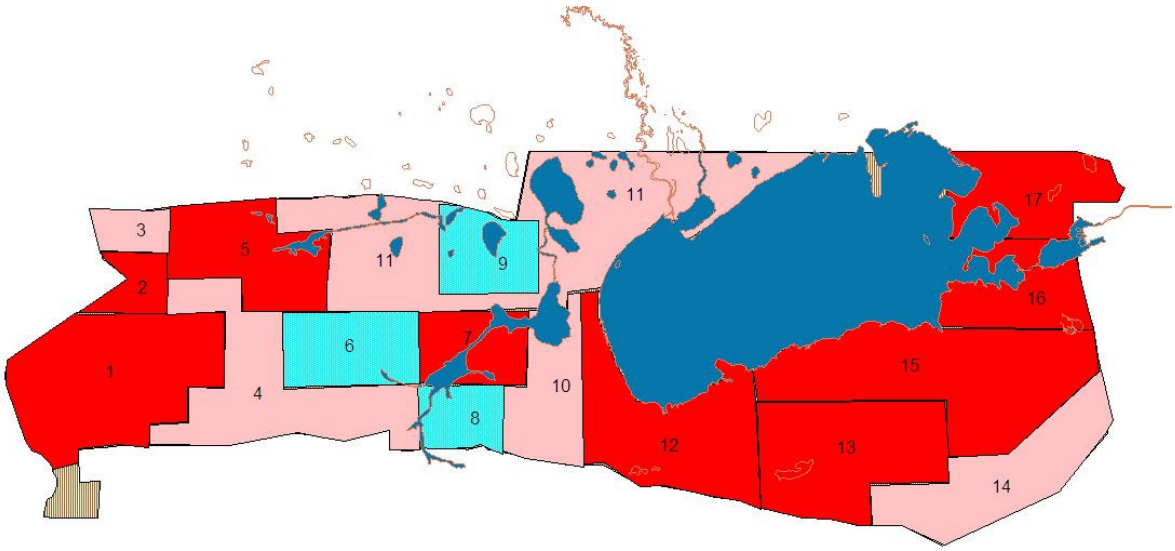
Pilot: Conrad Brain

Recorder: Werner Kilian

Left Observer: Johannes Kapner

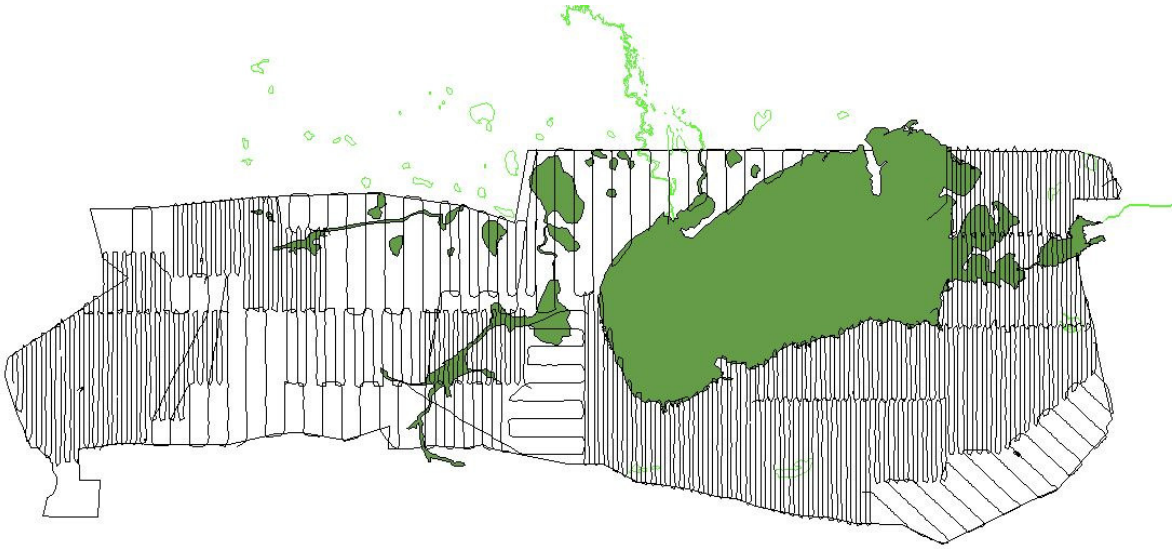
Right observer: Markus

Figure 1. Stratification and intensity of the 2015 aerial survey.



Survey blocks in red were sampled at 40% intensity, in blue at 20% and in light red at 10%.

Figure 2. Flight paths flown during 2015 aerial survey.



3. RESULTS.

Table 1 contains summary data for individual strata. Table 2 provides a summary of population estimates and densities. Population estimates for individual species are shown in Tables 3-13. Species distribution maps are shown in Figures 4 to13. The trend in population estimates from 1995 till 2015 is reflected in Figures 14 to 23.

Table 1. Summarized data per individual stratum for the 2015 Etosha aerial survey.

Block	Transect Spacing (km)	Area (km²)	Total Transect Length (km)	Average Height (ft agl)	Strip Width (m)	Block Width (km)	Possible Transects	Area Searched (km²)	Area of Block Searched (%)
ENP1	1.25	1728.118	1370.9	306	408	57.6	144	559.3	32.36552
ENP2	1.25	259.7612	202.5	307	409	24.3	61	82.9	31.91441
ENP3410	5.00	2396.1	467.6	309	412	137.6	344	192.6	8.039623
ENP5	1.25	1006.661	787.6	308	411	42.1	105	323.4	32.13053
ENP6	2.50	701.0328	280.0	304	405	35.0	88	113.5	16.18945
ENP7	1.25	600.6719	460.3	306	408	30.0	75	187.8	31.26431
ENP8	2.50	441.8536	158.1	301	401	25.0	63	63.4	14.35778
ENP9	2.50	665.4298	244.6	308	411	30.0	75	100.5	15.0984
ENP11	5.00	2811.934	541.9	312	416	141.2	353	225.4	8.016515
ENP12	1.25	1489.425	1193.3	309	412	46.2	116	491.6	33.00826
ENP13	1.25	1427.367	1141.9	318	424	50.0	125	484.2	33.92124
ENP14	5.00	1145.296	226.8	311	415	74.5	186	94.0	8.211701
ENP15	1.25	2038.162	1628.5	310	413	90.9	227	673.1	33.0258
ENP16	1.25	918.1365	728.3	316	421	41.3	103	306.9	33.42232
ENP17	1.25	921.1887	733.7	334	406	47.0	129	298.2	32.36725
		18551.14	**10166.0**					**4196.9**	22.62354

Table 2.Summary of species estimates and densities.

	Species	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
Ab	Red Hartebeest	247	424	889	1354	35329	465	0.523	0.048
Am	Springbok	2930	7998	10317	12636	1549199.6	2319	0.2248	0.556
Ct	Blue Wildebeest	1247	2822	4207	5592	417120.1	1385	0.3293	0.227
Db	Black Rhino	317	1098	1280	1462	7166.7	182	0.1419	0.069
Eb	Burchell's Zebra	4083	11338	14232	17126	1820077.6	2894	0.2033	0.767
Gc	Giraffe	878	2638	3172	3706	62010.7	534	0.1684	0.171
La	Elephant	890	2214	2911	3608	105660.2	697	0.2395	0.157
Og	Oryx	886	3373	4108	4843	91792.8	735	0.1789	0.221
Sc	Ostrich	783	2561	3695	4829	279615	1134	0.307	0.199
To	Eland	450	937	1321	1705	32017.0	384	29.05%	0.07

Table 3. Population estimate and related statistics for red hartebeest.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	50	49	154	260	2720.8	105	68.24%	0.09
ENP2	9	9	28	51	123.6	23	81.49%	0.11
ENP3410	9	9	112	295	7970.8	183	163.09%	0.05
ENP5	50	64	155	247	1988.4	91	58.56%	0.15
ENP6	23	23	142	391	13282.2	249	175.23%	0.20
ENP7	14	14	22	102	1469.1	79	355.03%	0.04
ENP8								0.00
ENP9								0.00
ENP11								0.00
ENP12	7	7	21	44	125.1	19	88.83%	0.01
ENP13	14	14	41	86	481.4	44	107.44%	0.03
ENP14								0.00
ENP15	43	43	130	252	3701.1	122	93.37%	0.06
ENP16	28	28	84	204	3466.5	120	143.40%	0.09
ENP17								0.00
Total	**247**	**424**	**889**	**1354**	**35329.0**	**465**	**52.30%**	**0.05**

Table 4. Population estimate and related statistics for springbok.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	204	204	630	1080	49531.3	450	71.36%	0.36
ENP2	316	456	991	1526	66825.0	535	53.96%	3.82
ENP3410	72	72	896	1726	165080.5	831	92.78%	0.37
ENP5	222	227	690	1154	51584.1	464	67.18%	0.69
ENP6	18	18	11	236	3322.4	125	111.98%	0.02
ENP7	78	78	249	525	17692.3	276	110.57%	0.41
ENP8	81	81	534	1135	67961.6	601	112.57%	1.21
ENP9								0.00
ENP11	48	48	599	1316	122815.7	718	119.87%	0.21
ENP12	1282	2225	3884	5543	673687.7	1659	42.71%	2.61
ENP13	5	5	15	41	165.5	26	176.40%	0.01
ENP14								0.00
ENP15	256	376	776	1176	40024.4	400	51.58%	0.38
ENP16	343	343	1027	2127	290294.1	1100	107.13%	2.32
ENP17	5	5	15	45	215.0	30	191.65%	0.02
Total	**2930**	**7998**	**10317**	**12636**	**1559199.6**	**2319**	**22.48%**	**0.56**

Table 5. Population estimate and related statistics for blue wildebeest.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	296	391	915	1438	67201.5	524	57.29%	0.53
ENP2	18	18	56	131	1305.2	75	132.40%	0.22
ENP3410	9	9	112	317	10075.2	205	183.36%	0.05
ENP5	33	33	103	244	4769.4	141	137.41%	0.10
ENP6	94	94	581	1212	85402.5	631	108.72%	0.83
ENP7	78	78	249	525	17692.3	276	110.57%	0.41
ENP8								0.00
ENP9								0.00
ENP11	2	2	25	74	581.0	49	197.92%	0.01
ENP12	288	288	872	1622	137357.8	749	85.85%	0.59
ENP13	15	15	44	122	1438.8	78	176.05%	0.03
ENP14								0.00
ENP15	298	332	903	1474	81620.1	571	6327.00%	0.44
ENP16	116	146	347	548	9676.3	201	57.83%	0.38
ENP17								0.00
Total	**1247**	**2822**	**4207**	**5592**	**417120.1**	**1385**	**32.93%**	**0.23**

Table 6. Population estimate and related statistics for black rhinoceros.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	53	101	164	226	963.6	63	38.13	0.09
ENP2	21	37	66	95	194.5	29	43.18%	0.25
ENP3410	11	43	137	231	2112.2	94	68.69%	0.06
ENP5	15	17	47	76	206.1	29	62.84%	0.05
ENP6	2	2	12	26	61.3	17	136.84%	0.02
ENP7	13	19	42	64	120.6	23	54.78%	0.07
ENP8	2	2	28	67	293.0	39	141.56%	0.06
ENP9								0.00
ENP11	1	1	12	32	131.0	23	87.88%	0.004
ENP12	50	92	151	211	870.4	60	39.36%	0.101
ENP13	46	82	136	189	693.0	53	39.23%	0.095
ENP14								0.000
ENP15	58	115	176	237	932.7	61	34.75%	0.086
ENP16	31	54	93	132	368.5	39	42.23%	0.101
ENP17	14	14	43	73	219.8	30	69.21%	0.047
Total	**317**	**1098**	**1280**	**1462**	**7166.7**	**182**	**14.19%**	**0.07**

Table 7. Population estimate and related statistics for plains zebra.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	985	2311	3043	3776	131352.1	732	24.07%	1.76
ENP2	264	535	828	1121	20095.5	293	35.42%	3.19
ENP3410	87	87	1082	2322	367837.6	1240	114.61%	0.45
ENP5	180	180	560	978	42013.7	419	74.77%	0.56
ENP6	46	46	284	754	47332.4	470	165.40%	0.41
ENP7	267	267	854	1571	119492.2	717	83.95%	1.42
ENP8	81	85	534	983	37972.9	449	84.14%	1.21
ENP9	4	4	26	83	641.4	56	213.16%	0.04
ENP11	49	49	611	1760	314899.7	1149	188.02%	0.22
ENP12	201	280	609	938	26433.9	329	53.96%	0.41
ENP13	370	695	1091	1486	38312.7	396	36.27%	0.76
ENP14	1	1	12	40	167.3	28	229.61%	0.01
ENP15	1083	1838	3282	4726	521547.5	1444	44.00%	1.61
ENP16	229	397	686	974	19997.4	289	42.11%	0.75
ENP17	236	236	730	1464	131981.3	734	100.60%	0.79
Total	**4083**	**11338**	**14232**	**17126**	**1820078**	**2894**	**20.33%**	**0.77**

Table 8. Population estimate and related statistics for Hartmann's zebra.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	295	346	869	1392	66931.8	523	60.18%	0.50
ENP2	2	2	6	14	14.7	8	133.92%	0.02
ENP3410								
ENP5								
ENP6								
ENP7								
ENP8								
ENP9								
ENP11								
ENP12								
ENP13								
ENP14								
ENP15								
ENP16								
ENP17								
Total	**297**	**348**	**875**	**1406**	**66946.5**			**0.05**

Table 9. Population estimate and related statistics for giraffe.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	187	406	578	750	7243.0	172	29.77%	0.33
ENP2	33	66	104	141	329.5	38	36.28%	0.40
ENP3410	36	218	448	678	12630.1	230	51.33%	0.19
ENP5	25	25	78	130	657.9	52	67.37%	0.08
ENP6								0.00
ENP7	44	44	141	237	2156.8	96	68.44%	0.23
ENP8	12	12	79	166	1425.1	87	110.03%	0.18
ENP9								0.00
ENP11	6	6	75	162	1791.1	87	115.81%	0.03
ENP12	86	173	261	348	1864.5	87	33.49%	0.18
ENP13	42	74	124	174	610.4	50	40.33%	0.09
ENP14	5	5	61	148	1628.1	87	143.26%	0.05
ENP15	132	132	400	677	19191.3	277	69.26%	0.20
ENP16	120	120	359	521	6282.2	162	45.04%	0.39
ENP17	150	275	464	623	6200.7	159	34.31%	0.50
Total	**878**	**2638**	**3172**	**3706**	**62010.7**	**534**	**16.84%**	**0.17**

Table 10. Population estimate and related statistics for elephant.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	131	191	405	619	11210.2	214	52.87%	0.23
ENP2	29	29	91	161	1153.5	70	77.26%	0.35
ENP3410								0.00
ENP5	27	27	84	140	765.8	57	67.30%	0.08
ENP6	11	11	68	167	2088.0	99	145.27%	0.10
ENP7	50	50	160	286	3694.2	126	78.82%	0.27
ENP8								0.00
ENP9	41	41	271	537	14243.2	266	98.00%	0.41
ENP11								0.00
ENP12	99	99	300	502	10046.0	203	67.54%	0.20
ENP13	22	22	65	159	2158.9	94	144.78%	0.05
ENP14	1	1	12	40	161.6	27	225.66%	0.01
ENP15	181	287	549	810	17090.8	261	47.67%	0.27
ENP16	153	153	458	790	26462.5	332	72.51%	0.50
ENP17	145	188	448	709	16585.5	260	58.05%	0.49
Total	**890**	**2214**	**2911**	**3608**	**105660.2**	**697**	**23.95%**	**0.16**

Table 11. Population estimate and related statistics for gemsbok.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	27	433	640	846	10436.9	206	32.28%	0.37
ENP2	104	169	326	484	5801.9	158	48.31%	1.25
ENP3410	43	254	535	815	18803.8	280	52.43%	0.22
ENP5	107	208	333	458	3750.8	125	37.58%	0.33
ENP6	30	79	185	292	2422.8	106	57.38%	0.26
ENP7	58	88	186	283	2217.7	98	52.65%	0.31
ENP8	39	39	257	524	13419.0	267	103.89%	0.58
ENP9	9	9	58	154	1846.7	96	164.67%	0.09
ENP11	17	74	212	350	4516.0	138	64.90%	0.08
ENP12	184	335	557	780	12163.4	223	39.99%	0.37
ENP13	63	97	186	275	1942.4	89	47.96%	0.13
ENP14	1	1	12	39	154.6	27	154.60%	0.01
ENP15	51	51	155	280	3948.0	126	81.31%	0.08
ENP16	78	78	234	395	6228.5	161	69.00%	0.25
ENP17	75	102	232	362	4140.3	130	56.07%	0.25
Total	**886**	**3373**	**4108**	**4843**	**91792.8**	**735**	**17.89%**	**0.22**

Table 12. Population estimate and related statistics for ostrich.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	145	315	448	581	4302.8	133	29.59%	0.26
ENP2	36	45	113	181	1075.2	68	60.09%	0.44
ENP3410	43	303	535	767	12896.1	232	43.42%	0.22
ENP5	83	199	258	318	848.0	59	23.04%	0.26
ENP6	8	8	53	112	722.5	59	110.06%	0.08
ENP7	66	99	211	323	2933.6	112	53.21%	0.35
ENP8	24	24	158	301	3819.7	143	90.07%	0.36
ENP9	5	5	33	64	198.4	31	94.84%	0.05
ENP11	77	77	961	1951	233686.6	990	103.07%	0.34
ENP12	95	135	288	441	5716.7	153	53.09%	0.19
ENP13	32	45	94	144	596.1	49	52.31%	0.07
ENP14	3	3	37	79	387.9	43	116.54%	0.03
ENP15	47	58	142	227	1793.7	85	59.47%	0.07
ENP16	41	41	123	212	1910.9	89	72.71%	0.13
ENP17	78	78	241	430	8726.8	189	78.27%	0.26
Total	**783**	**2561**	**3695**	**4829**	**279615.0**	**1134**	**30.70%**	**0.20**

Table 13. Population estimate and related statistics for eland.

Block	No seen	Lower	Estimate	Upper	Variance	95% Confidence Interval	CI as % of Population Estimate	Density (no/km²)
ENP1	57	57	168	280	3073.5	112	66.74%	0.10
ENP2								0.00
ENP3410	3	3	35	77	435.9	43	123.03%	0.01
ENP5	70	103	211	319	2810.0	108	51.30%	0.21
ENP6	31	31	95	208	3015.3	113	119.32%	0.13
ENP7								0.00
ENP8								0.00
ENP9								0.00
ENP11								0.00
ENP12	3	3	9	23	52.0	15	164.26%	0.01
ENP13	10	10	30	70	394.6	40	134.89%	0.02
ENP14								0.00
ENP15	2	2	6	16	23.4	10	163.85%	0.00
ENP16	8	8	24	50	166.9	26	110.13%	0.03
ENP17	117	120	350	580	12973.2	230	65.82%	0.38
Total	**301**	**778**	**1103**	**1428**	**22944.8**	**325**	**29.46%**	**0.06**

4. Species distribution maps.

Figure. 3. Spatial distribution of red hartebeest.

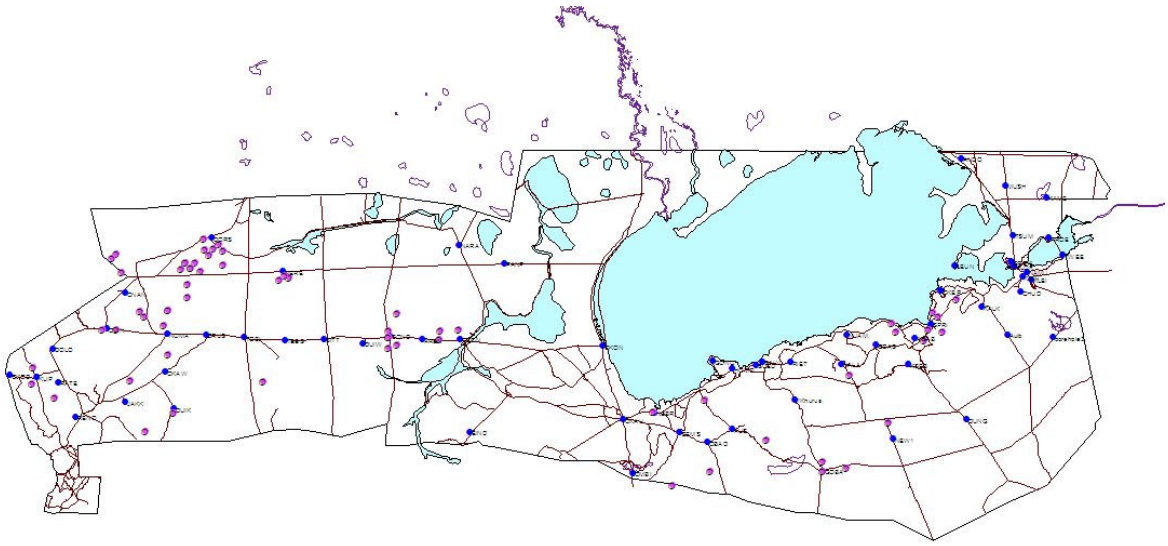


Figure 4. Spatial distribution of springbok.

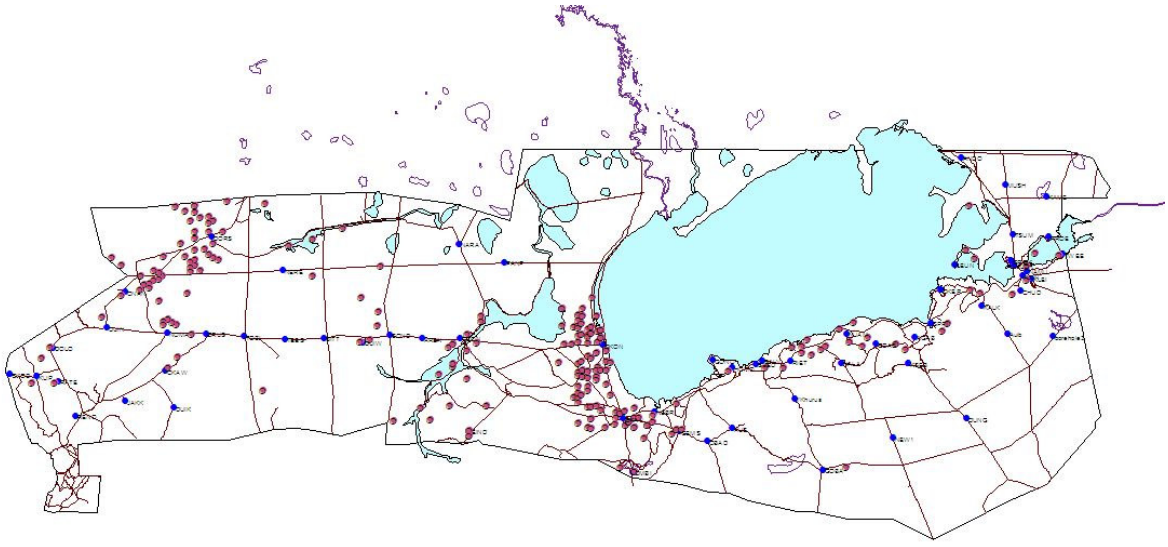


Figure 5. Spatial distribution of blue wildebeest

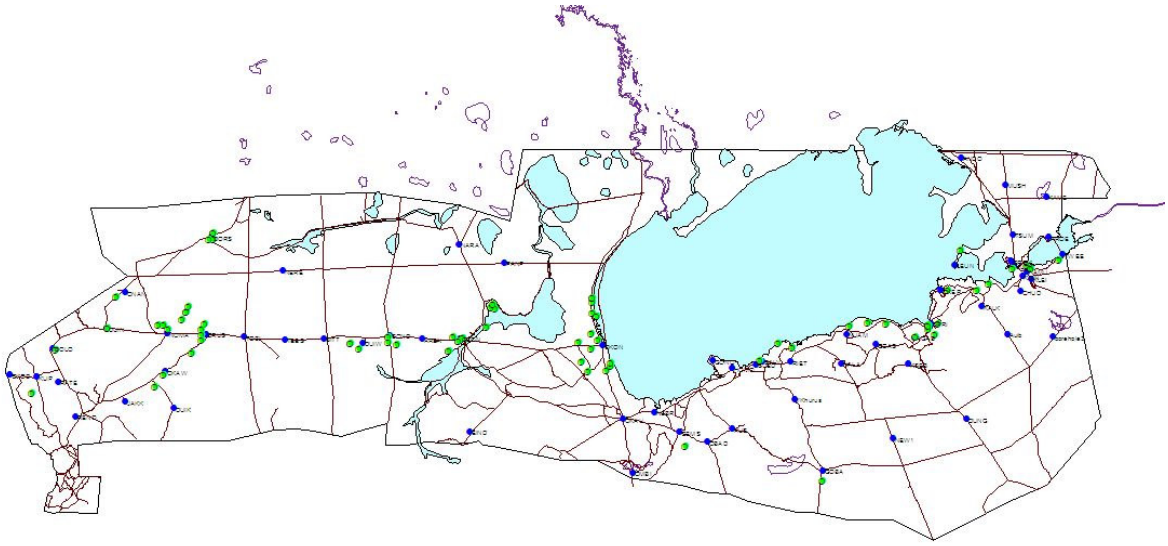


Figure 6. Spatial distribution of black rhinoceros.

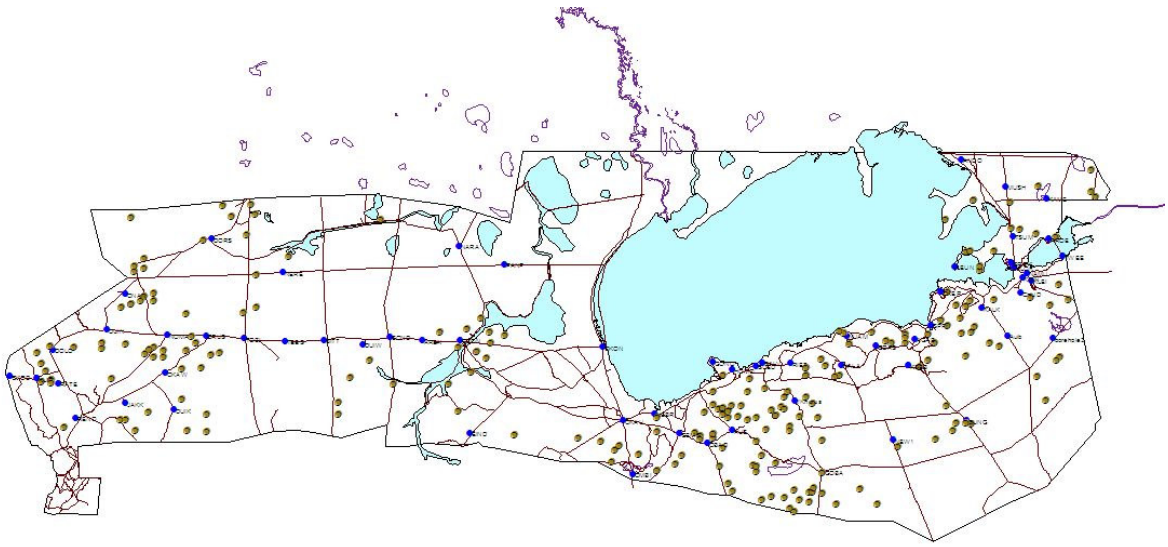


Figure 7. Spatial distribution of plains zebra.

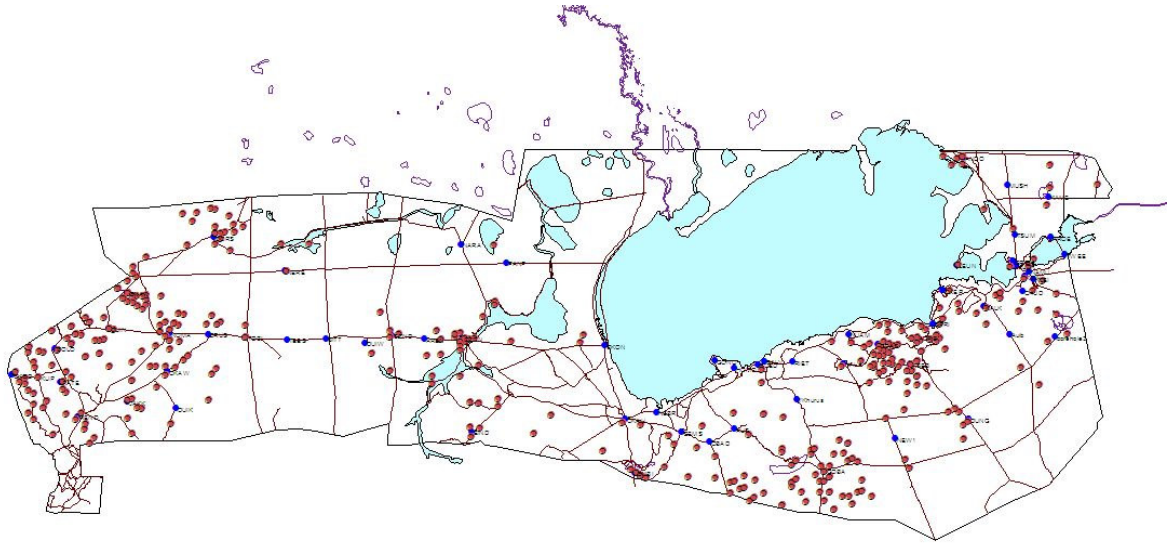


Figure 8. Spatial distribution of Hartmann's zebra.

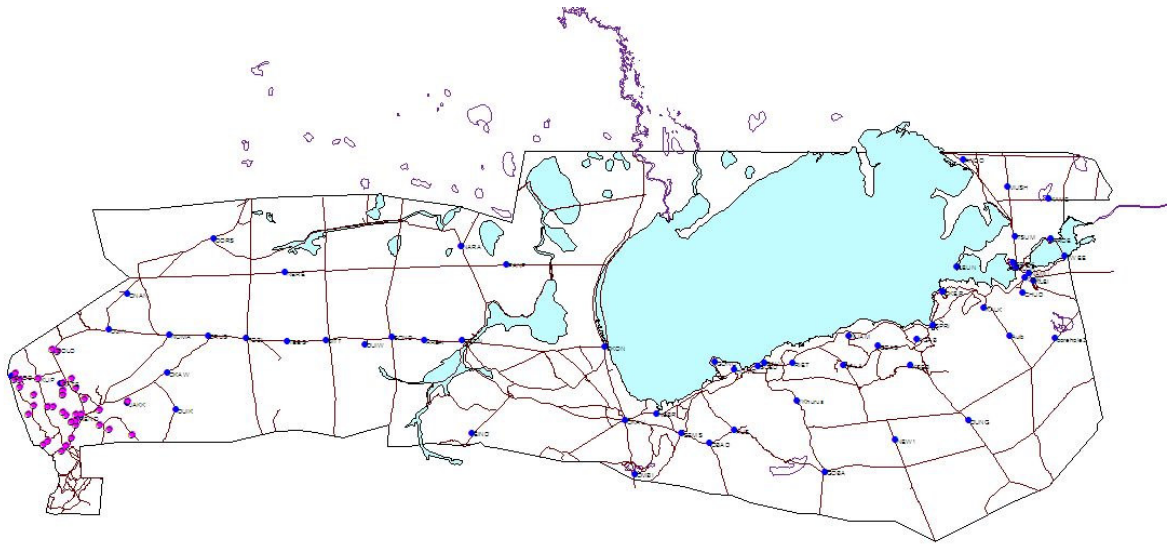


Figure 9. Spatial distribution of giraffe.

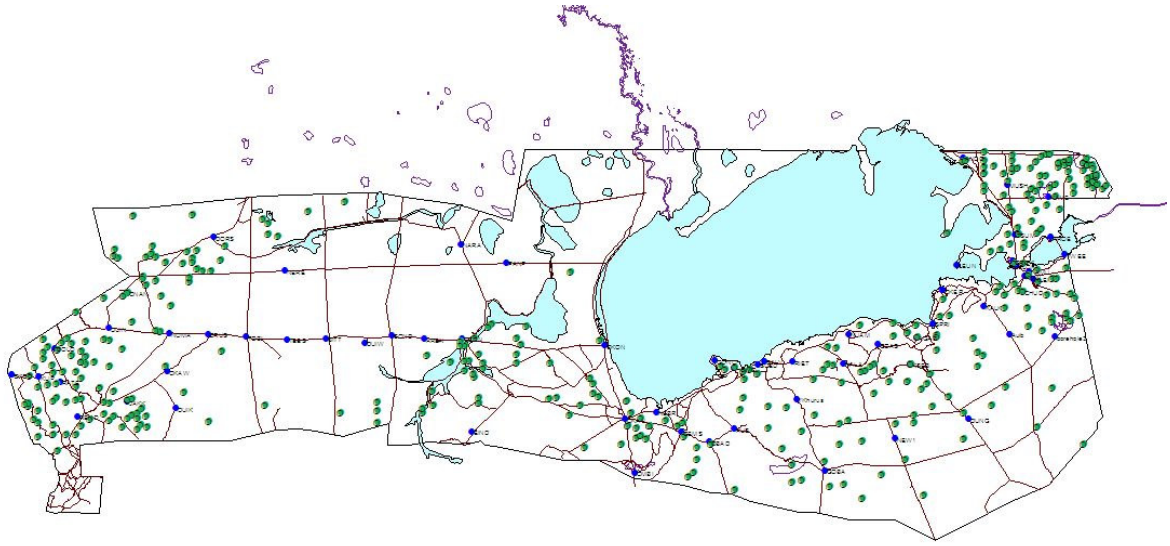


Figure 10. Spatial distribution of elephant.

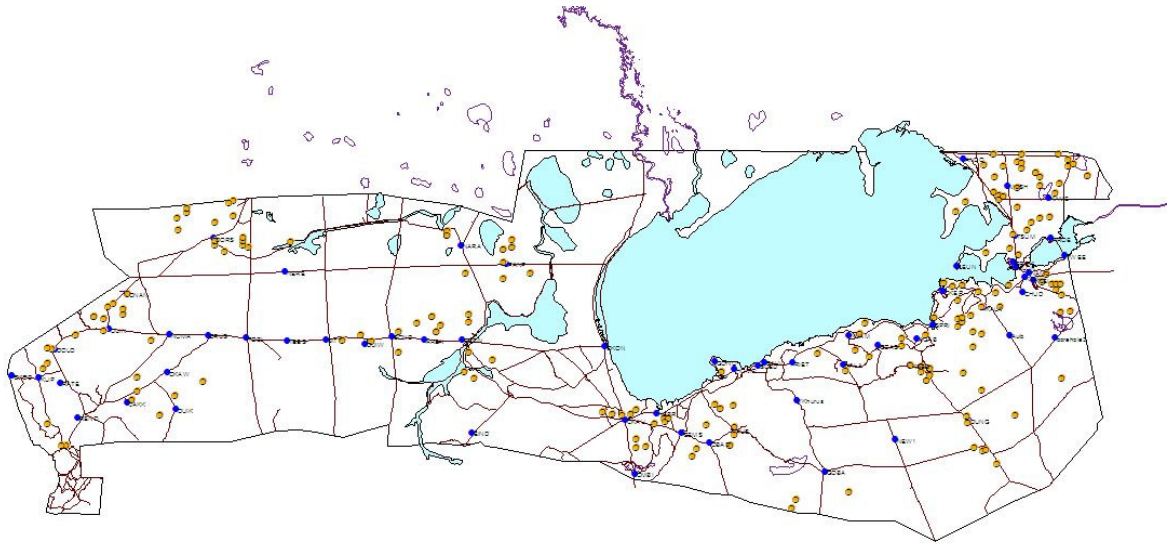


Figure 11. Spatial distribution of gemsbok.

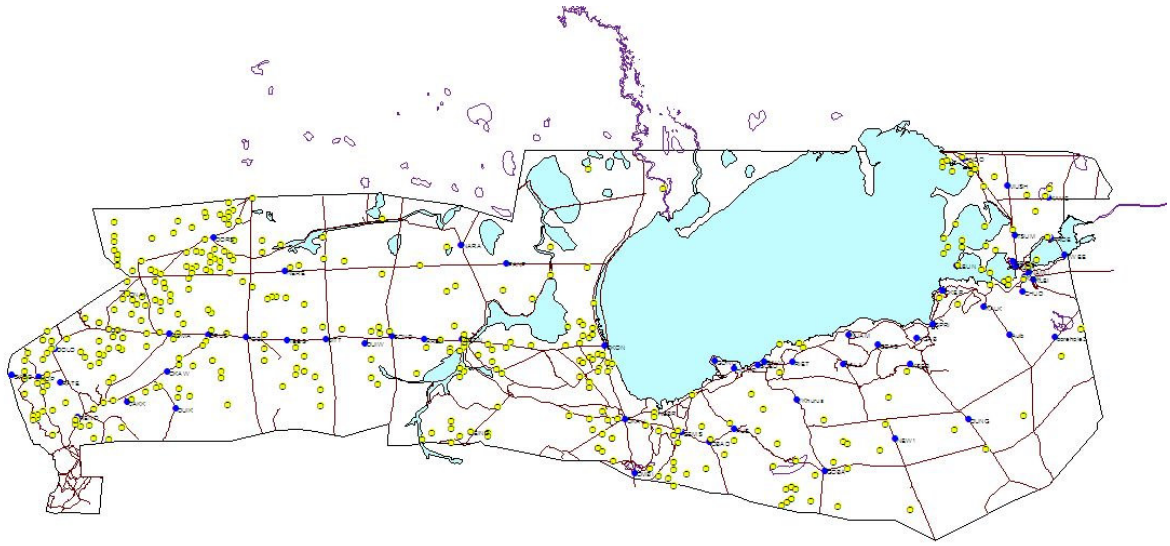


Figure 12. Spatial distribution of ostrich.

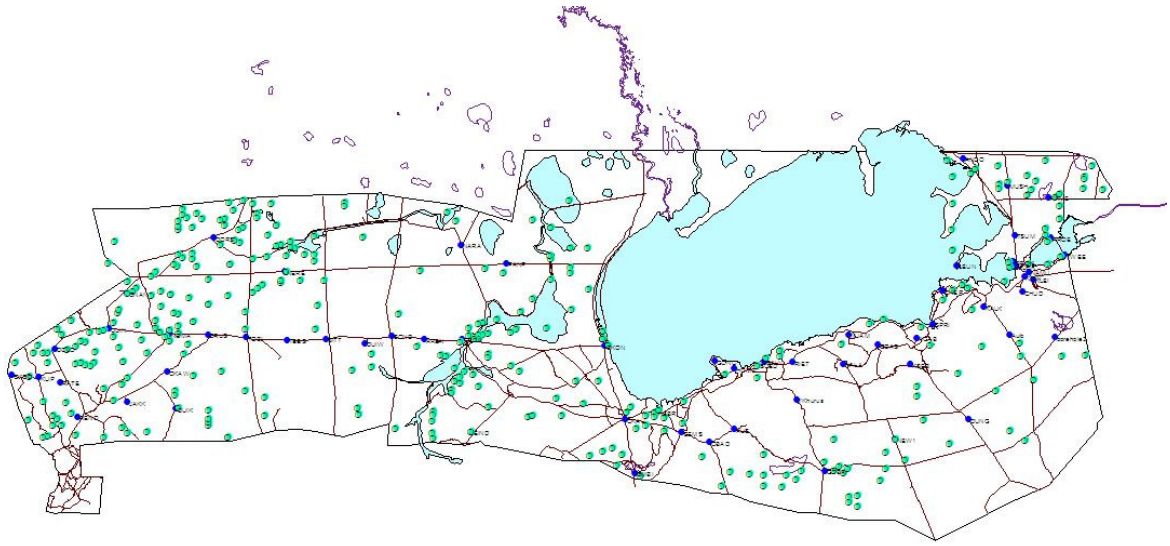
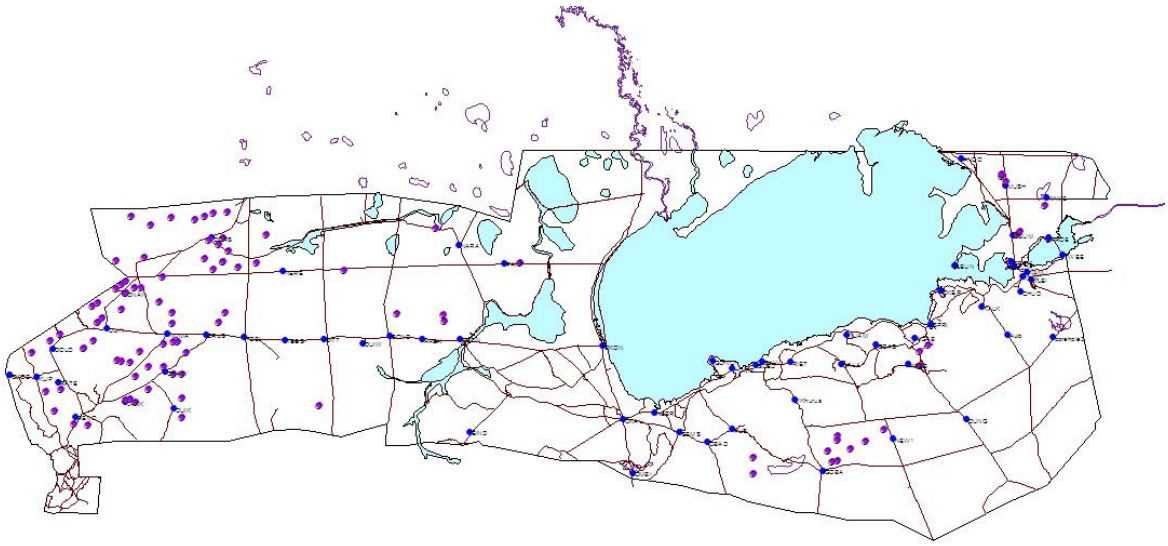


Figure 13. Spatial distribution of eland.



5. Species population trends

Figure 14. Population trend for red hartebeest.

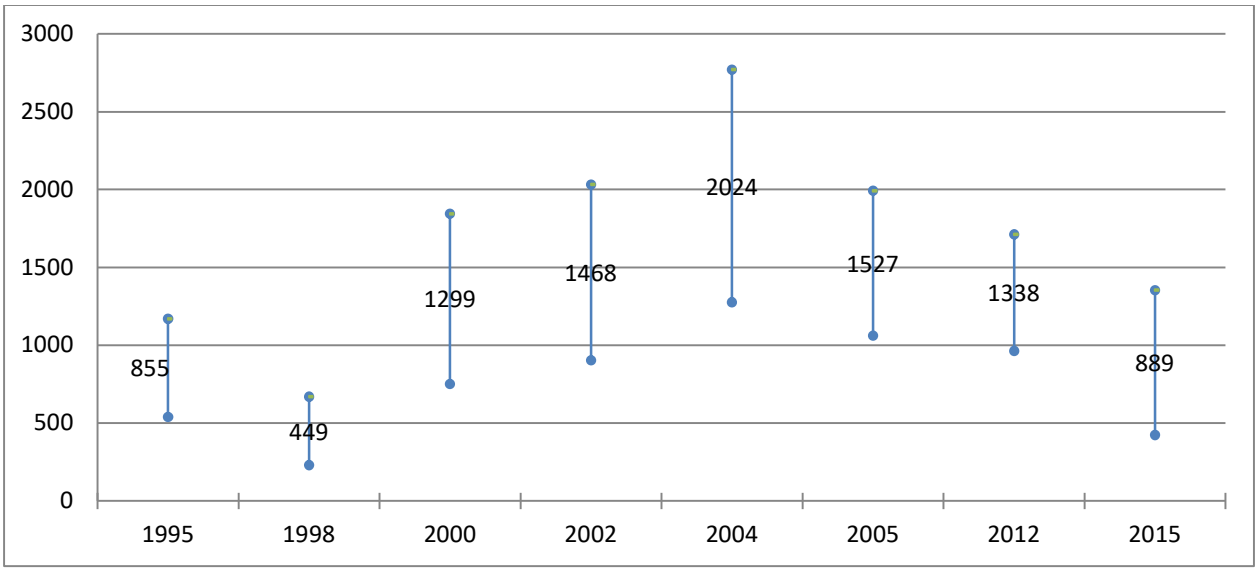


Figure 15. Population trend for springbok.

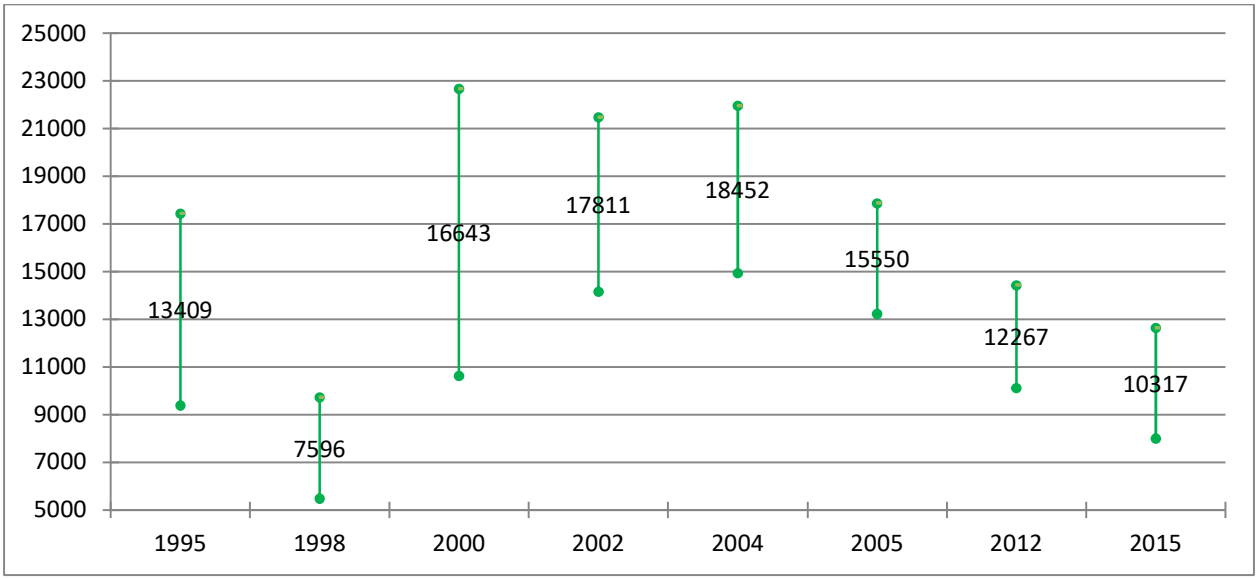


Figure 16. Population trend for blue wildebeest.

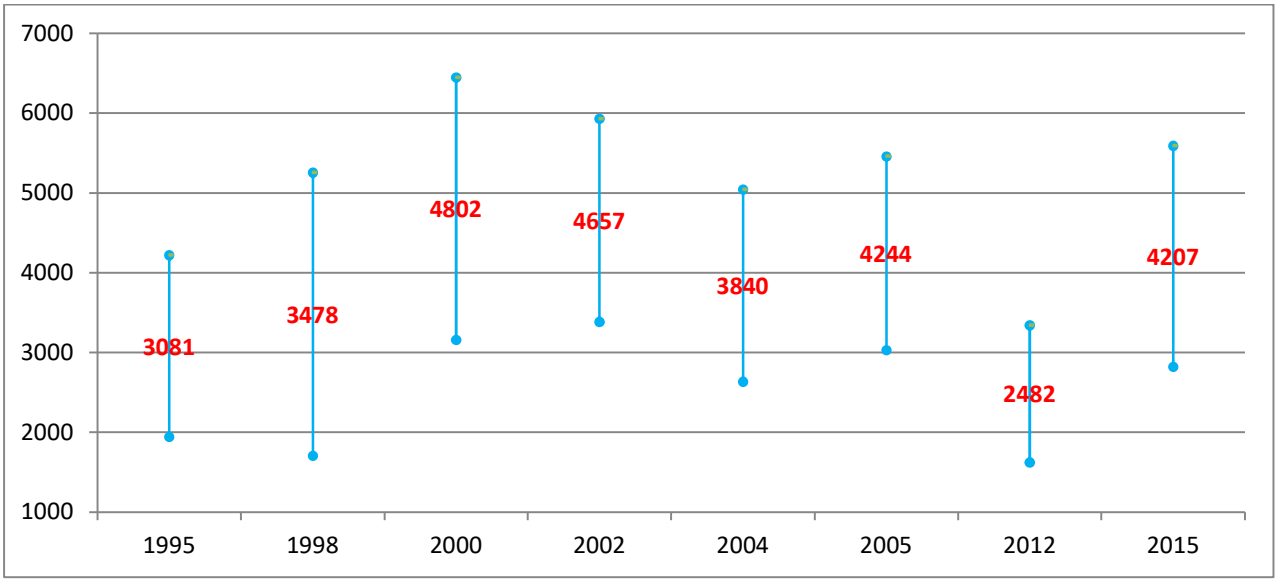


Figure 17. Population trend for black rhinoceros.

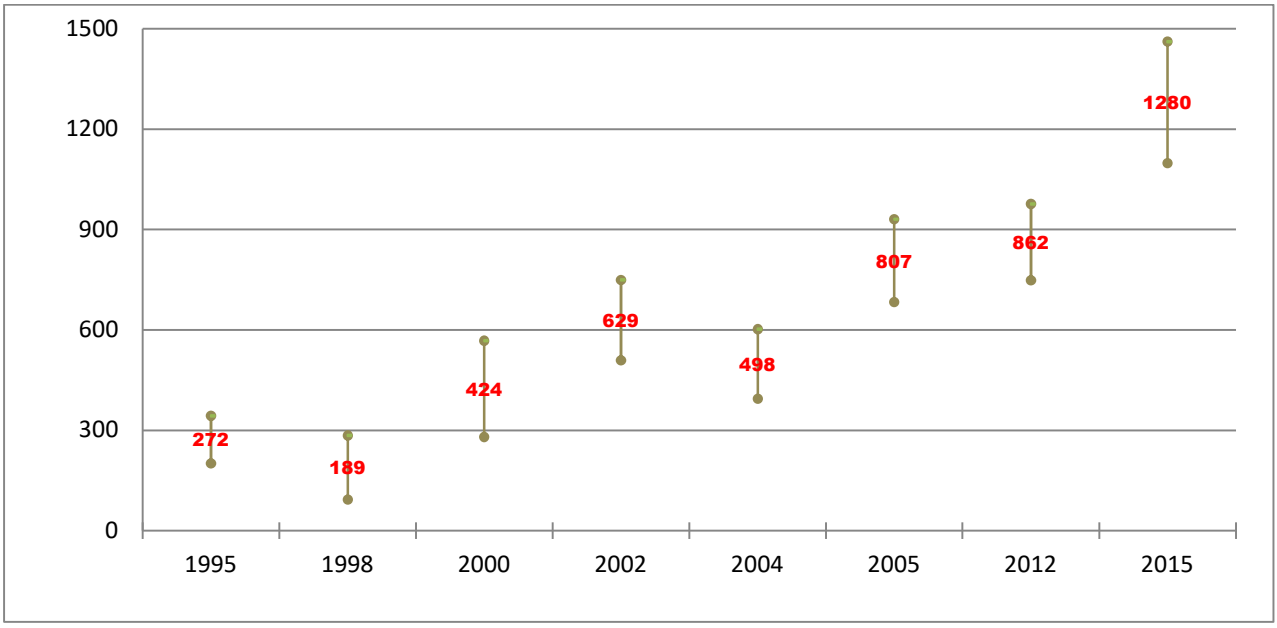


Figure 18. Population trend for Burchell's zebra.

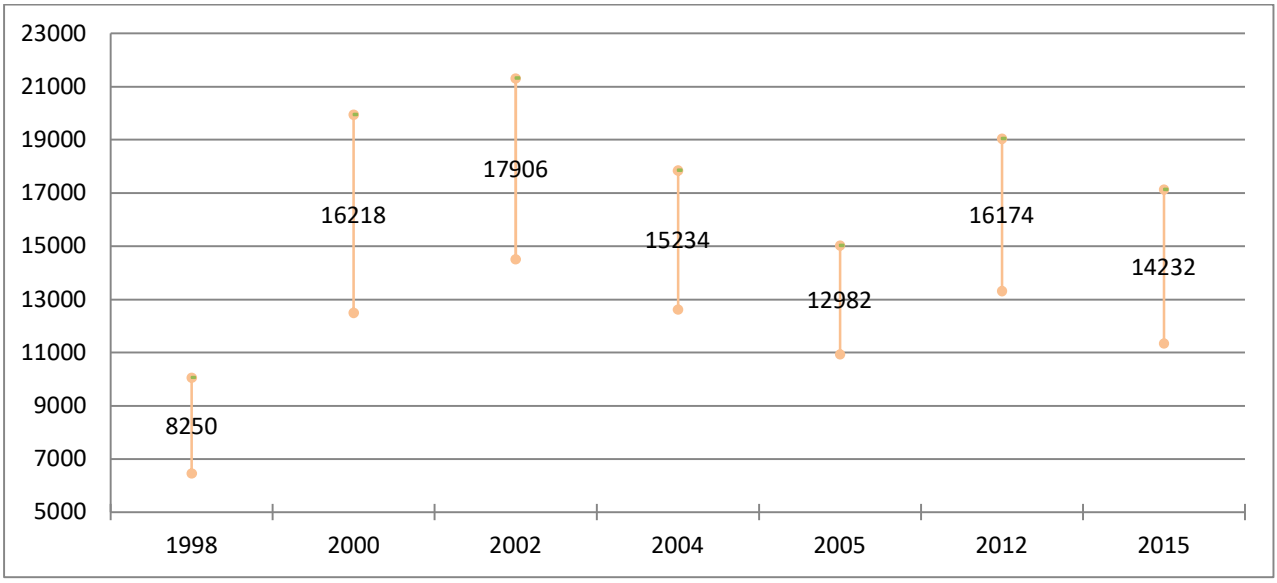


Figure 19. Population trend for giraffe.

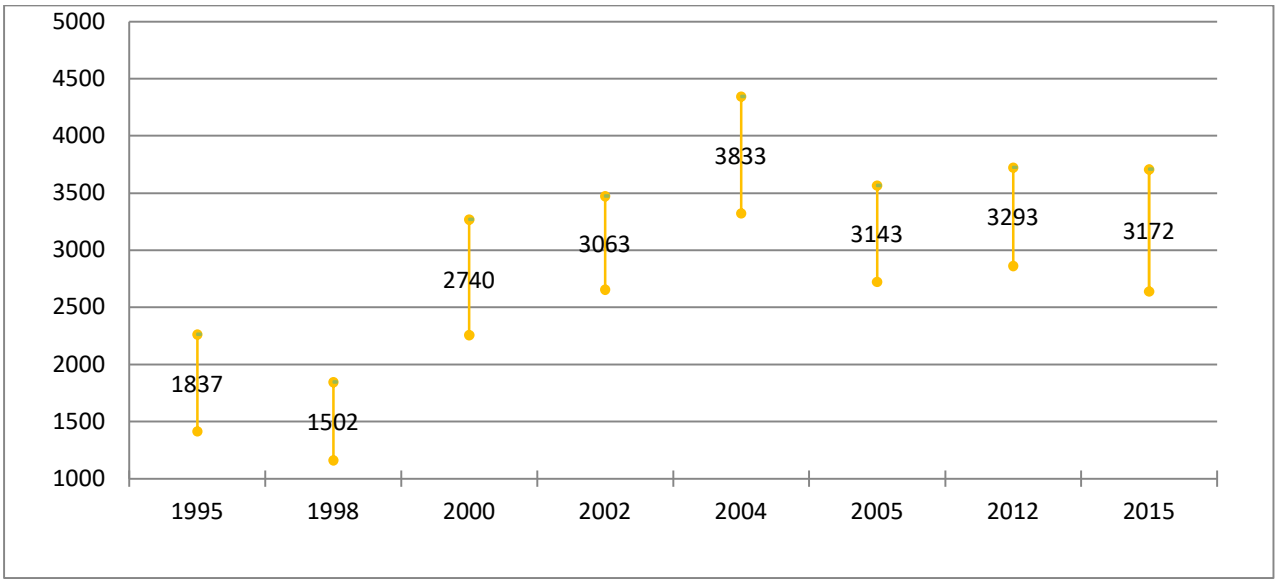


Figure 20. Population trend for elephant.

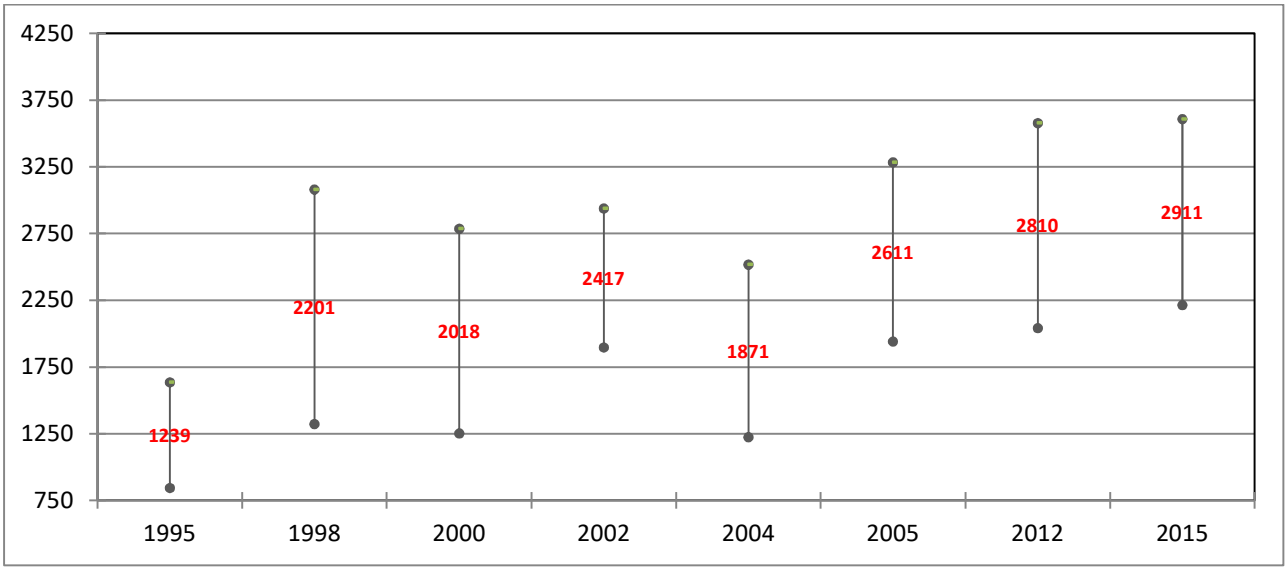


Figure 21. Population trend for gemsbok.

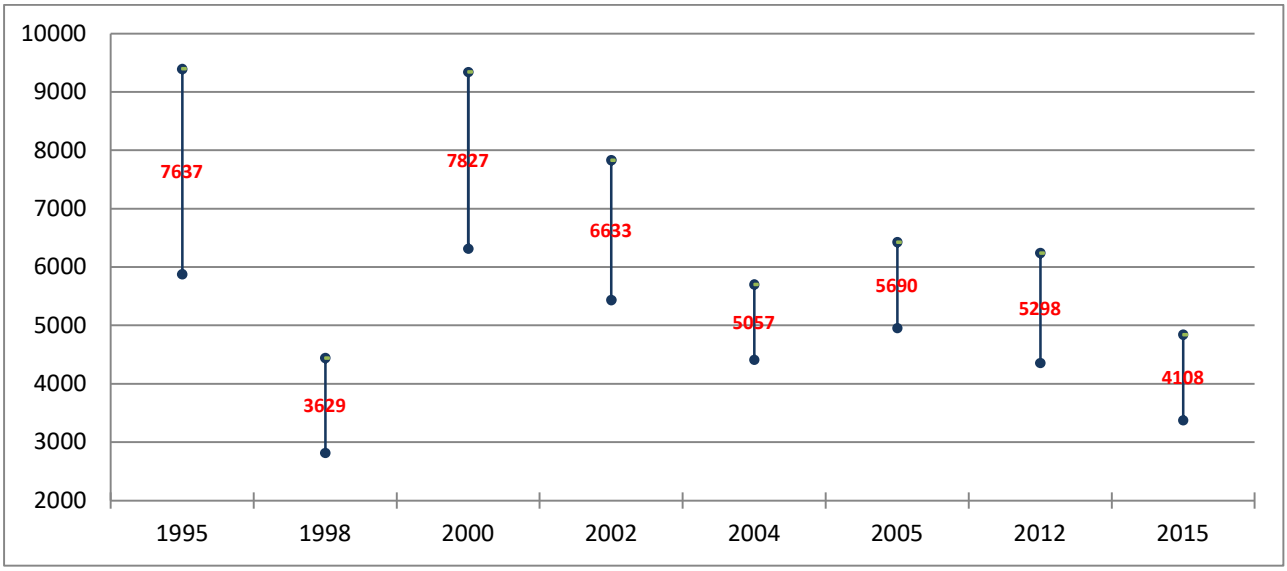


Figure 22. Population trend for ostrich.

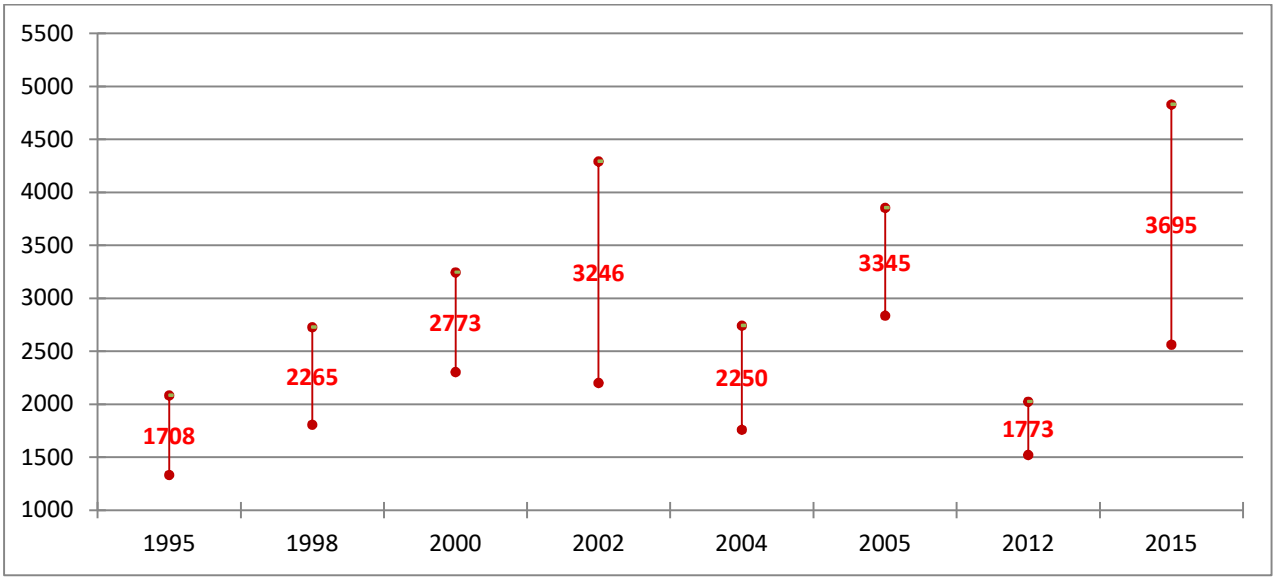
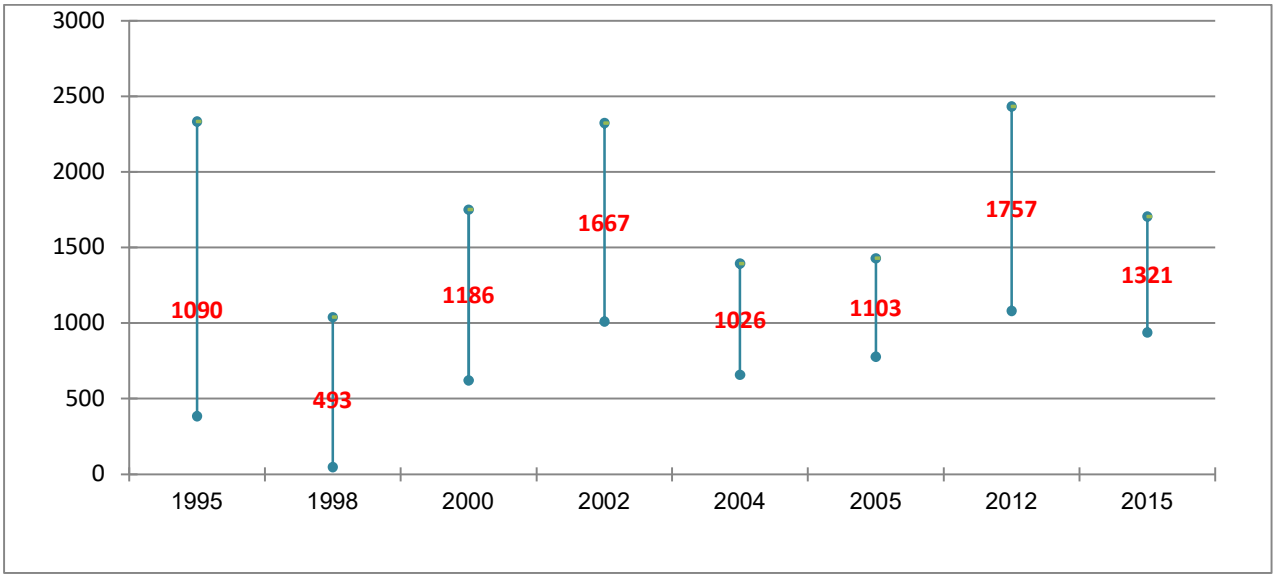


Figure 23. Population trend for eland.



The population trend shows an apparent decline for red hartebeest, Springbok and gemsbok, an apparent increase in ostrich, and stable estimates for all other species excluding black rhinoceros estimates which are not shown here. Climatically, Etosha is a highly variable environment , where population fluctuations are expected to be the norm. Attempts to interpret possible population declines or increases should consider

climatic fluctuations as well as other potential influential factors related to sample counts, including aggregations, visibility of cryptic species and time of day inter alia.

6. ACKNOWLEDGEMENTS

The survey team is thanked for their outstanding conduct in completing this count in the most professional manner. Wilderness Safaris is thanked for releasing Nad Brain as the pilot for this survey. Under flying conditions that were hazardous at best, Nad Brain did a stirling job as pilot, which again emphasized that there is no replacement for experience.

Marthin Kasaona is thanked for his efforts and contribution in fuel management and general logistics.

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