WILDLIFE MONITORING

IN NORTH-WESTERN NAMIBIA

D. St.C. Gibson, Editor

March 2001

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D. St.C. Gibson

1. EVENTS AFFECTING WILDLIFE POPULATIONS

Various writings (Viljoen 1982, Owen-Smith 1986) suggest that wildlife was abundant and widespread in NW Namibia and continued to flourish after the area was proclaimed a protected area in 1907 and a Game Reserve in 1928. However, in 1964 the area was deproclaimed (Odendaal 1964) to form "homelands" for indigenous peoples. With the provision of boreholes and veterinary services, domestic livestock increased and began to compete with wild animals for resources and wildlife began to decline.

In about 1975 Portuguese refugees from newly independent Angola began hunting in northern Namibia and by 1977 it became apparent that government staff from within the area, high-ranking civil servants and members of the SADF were also poaching (B. Loutit *pers. comm.*, R. Loutit *pers. comm.*, T. Hall *pers. comm.*, G. Owen-Smith *pers. comm.*, Owen-Smith 1986, Viljoen 1988, Carter 1990) (Fig. 1). Although all species were hunted, Burchell's zebra , elephant and rhino were particularly sought after for their skins, ivory and horns - it was thought that there were no more than about 50 elephants and 15 rhinos left in Kaokoland by the late 1970s/early 1980s and Burchell's zebra had declined from thousands to less than 100.

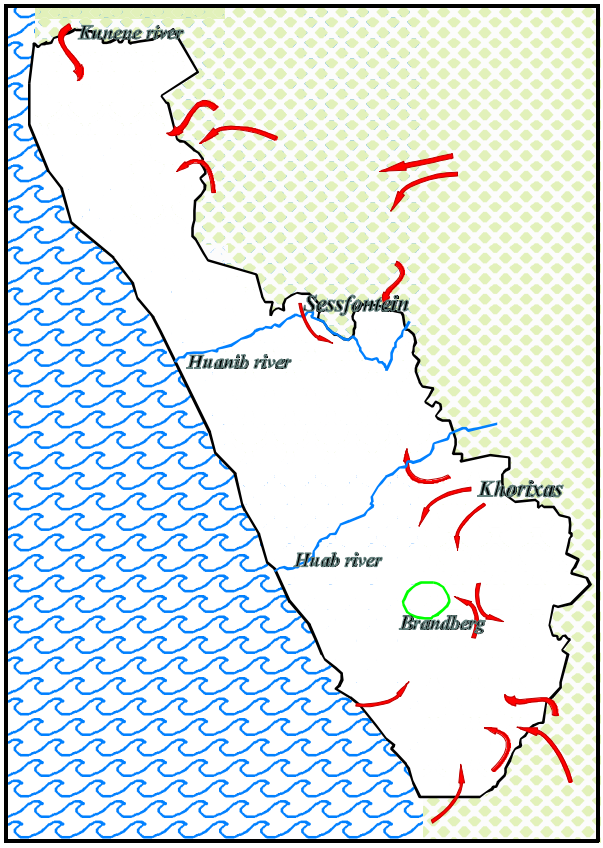

Figure 1 Sources of illegal hunting during the 1970s in NW Namibia

Devastating droughts (Figs 2 & 3) in the early 1980s accelerated the wildlife decline and affected even animals such as Hartmann's zebra which, being difficult to hunt had survived the poaching. Perhaps more importantly, livestock crashed from an estimated 160000 to about 15000. People had to turn to hunting for their survival, and having been provided with weapons and ammunition during the independence struggle, their impact on remaining wildlife was severe.

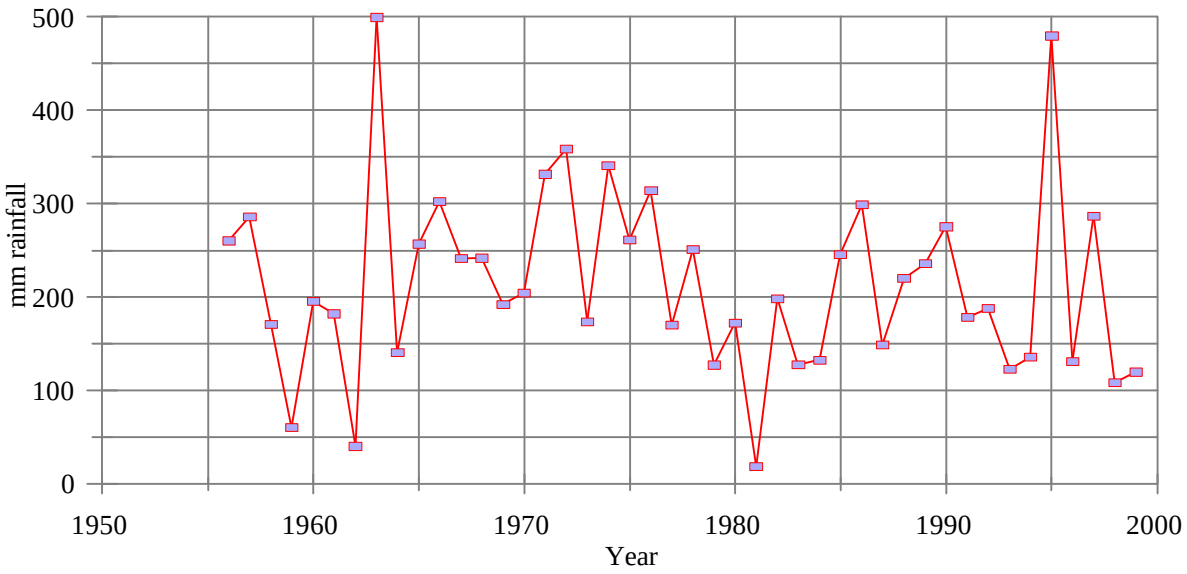

Figure 3 Khorixas rainfall

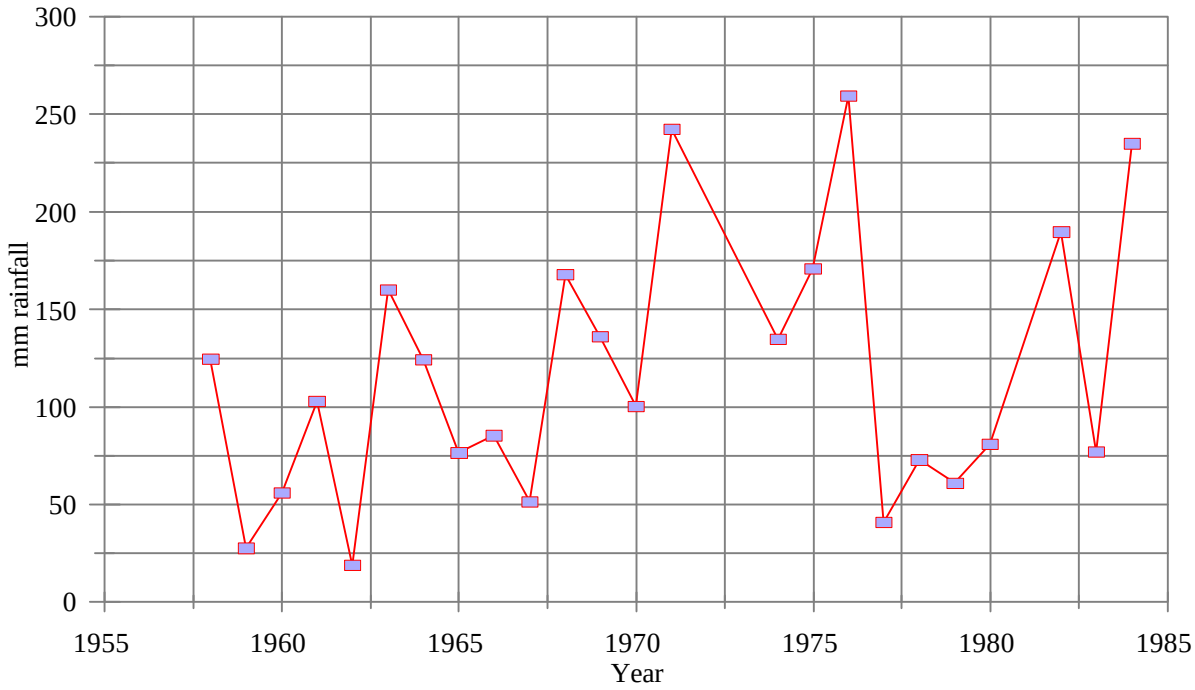

Figure 2 Sesfontein Rainfall

Between 1977 and 1986 government Nature Conservators in the Skeleton Coast Park began anti-poaching patrols inland. Until 1978 Europeans were not allowed into the area without a permit and there was little control on illegal hunting. This requirement was withdrawn in 1978 and in 1981 a government Nature Conservator was posted in Damaraland. By this time the only reasonably large populations of wild animals were found in a relatively small area south of the Huanib River (R. Loutit *pers. comm.*). With the establishment of the Namibia Wildlife Trust in 1982 came "auxiliary game guards" whose efforts combined with the anti-poaching patrols of the government conservators from Damaraland and the Skeleton Coast Park to take the first positive steps towards helping the recovery of the wildlife. The end of drought (Figs 2 & 3) and the work of MET anti-poaching patrols and extension officers, Save the Rhino (SRT) trackers, safari operators and Community Game Guards all contributed to an increase and expansion of wild animals in the north west which continues today.

2. MONITORING

Monitoring wildlife in NW Namibia has been going on throughout the period summarised above, although the aims, methods and outputs have varied in detail. The various monitoring activities are summarised in Table 1.

2.1 Informal *ad hoc* monitoring

Until about 1975, observations of wildlife were made *ad hoc* in the course of other work by agricultural, administrative staff and other government staff. This information provided the first indications of the declines in wildlife in the north, giving people in the field an informal idea of the abundance, distribution and activities of animals. Despite its lack of formal structure, the sort of background information that comes from general observations has considerable value in assisting the design of other monitoring schemes and also enables patrols to be done to maximum effect.

2.2 Fixed route patrols

There has been somewhat more rigorous monitoring in the form of records maintained during patrols along fixed routes, a system that was started from the Skeleton Coast Park in 1977 (R. Loutit *pers. comm.*). Apart from making notes of the species, sex and age of animals seen, their location was recorded by making a note of the mileage reading on the odometer of the vehicle, usually with a note of the locality.

These data were extremely useful at the time to monitor where animals might be concentrating, so that increased anti-poaching effort could be made in the right places, and to observe the population health through age structure and juvenile recruitment. In order to carry out a rigorous analysis of these aspects of past population ecology it would be necessary to discard weak data sets (eg. where only part of the group was classified) as variations in the quality of the data are likely to produce misleading and biassed results.

Table 1. Summary of monitoring activities in NW Namibia since 1967 (excluding Hobatere area)

YEAR	SURVEY	OUTCOME
1967 - 1970	*ad hoc* observations - Kaokoland	Idea of wildlife abundance & seasonal movements obtained & observations of probable decline
1975	aerial survey of elephants - Hoanib R. & plains S. of Sessfontein	Location of eles in surveyed area - not comparable
1977	aerial survey of elephants (Jan) - n. of vet fence/Uniab catchment	Location of eles in surveyed area - not comparable
1979	aerial survey of elephants (Oct) - n. of vet fence SW of Hobatere	Location of eles in surveyed area - not comparable
1981	aerial survey of elephants (Apr) - catchments Hoanib - vet fence	Location of eles in surveyed area - not comparable
1981 - now?	*ad hoc* observations during anti-poaching patrols	Idea of wildlife abundance, seasonal movements & trends obtained
1981 - 199?	fixed road patrols, records kept of sightings, location	Monitoring movements/herd structure/recruitment
1982	aerial survey Kaokoland & Damaraland	Estimates of all species & rough indication of density-distribution
1983 - ??	ad hoc observations during patrols by aux game guards	Idea of wildlife abundance, seasonal movements & trends obtained
1983	aerial surveys in Damaraland (May & Aug)	Wildlife numbers & distrib. in surveyed area
1985	aerial survey Kaokoland & Damaraland (partial) (Oct)	Numbers & location of elephant in surveyed areas
1986	aerial survey Huab valley (June)	Location of eles in surveyed area - not comparable
1985 - 1992	regular aerial surveys of elephants: catchments Hoanib - Huab (not all of same coverage or intensity) as follows:	Seasonal locations of eles in surveyed areas - not all comparable
1986	aerial survey of Damaraland (Jul/Aug) (partial)	Numbers of all species & rough indication of density-distributions
1987	aerial survey of Damaraland (Dec) (partial)	Numbers & location of elephant in surveyed areas
1988	aerial survey of Damaraland (May) (partial)	Numbers & location of elephant in surveyed areas
1988	aerial survey of Damaraland (Aug) (partial)	Numbers & location of elephant in surveyed areas
1988	aerial survey of Damaraland (Sep) (partial)	Numbers & location of elephant in surveyed areas
1989	aerial survey of Damaraland (Apr/May) (partial)	Numbers & location of elephant in surveyed areas
1989	aerial survey of Damaraland (Jun) (partial)	Numbers & location of elephant in surveyed areas
1989	aerial survey of Damaraland (Aug) (partial)	Numbers & location of elephant in surveyed areas

Table 1. (continued)

1989	aerial survey of Damaraland (Sep) (partial)	Numbers & location of elephant in surveyed areas
1989	aerial survey of Damaraland (Oct) (partial)	Numbers & location of elephant in surveyed areas
1990	aerial survey of Damaraland (Jan) (partial)	Numbers & location of elephant in surveyed areas
1990	aerial survey Kaokoland & Damaraland (May) - extensive survey	Numbers of all species & rough indication of density-distributions
1990	aerial survey of Damaraland (Nov) (partial)	Numbers & location of elephant in surveyed areas
1991	aerial survey of Damaraland (Jan) (partial)	Numbers & location of elephant in surveyed areas
1991	aerial survey of Damaraland (May) (partial)	Numbers & location of elephant in surveyed areas
1991	aerial survey of Damaraland (Dec) (partial)	Numbers & location of elephant in surveyed areas
1992	aerial survey of Damaraland (Jan) (partial)	Numbers & location of elephant in surveyed areas
1992	aerial survey of Damaraland (Apr) (partial)	Numbers & location of elephant in surveyed areas
1992	aerial survey of elephants Kaokoland & Damaraland (Aug)	Numbers & location of elephant in surveyed areas
1995	aerial survey of elephants Kaokoland & Damaraland	Numbers & location of elephant in surveyed areas
199?	community game guard counts	Status, distribution, activities of & impacts on wildlife monitored
1998	aerial survey Kaokoland & Damaraland (sample count)	Estimates of all species & density-distributions mapped
1999	aerial count of Hoanib River & low % of catchment area	Numbers of elephant in river
2000	aerial count of Hoanib River & low % of catchment area	Numbers of elephant in river
2000	fixed road counts in Conservancies	Estimates of all species
2000	aerial survey Kaokoland & Damaraland (sample count)	Estimates of all species & density-distributions mapped

These fixed patrol data were not collated until recently when they were put into an MS Access database (B. Paterson, DRFN) and there has been no comprehensive analysis. The most recently upgraded version of the database is currently held in Mowe Bay in the Skeleton Coast Park (B. Paterson, *pers. comm.*). Where possible (depending on the contents of the original patrol records), the database has included records of species, numbers seen, location (either according to a system of coded grid squares or as distance along a route), sex and age structure, the date and the name of the observer.

With this version are maps of the routes taken by the patrols, or maps showing the grid system so that analysis of the data for abundance indices and an indication of distributions should be feasible. The data are probably also useful for showing localised seasonal movements (eg Hartmann's zebra movement from mountains to plains in response to rains).

2.3 Questionnaires

The SRT used questionnaires to determine numbers of wild animals on the farms in Damaraland. Unfortunately, the data sheets were unexpectedly missing from their folders and therefore could not be examined.

2.4 Game guard monitoring

Game guards have reported on wildlife in the course of their patrols but no analysis of these has taken place.

More recently a system (mid 2000) has been set up to facilitate record-keeping by community game guards in the course of a variety of monitoring activities in the conservancies. Information is recorded in "Event Books" which are kept by the community game guards. The records include:

- Event monitoring
  - rainfall (daily records summed to give monthly totals)
  - poaching, stock theft, problem animal incidents (date, locality, cause etc.)
- Biological monitoring -
  - sightings of common animals seen during patrols (date, locality, species, number)
  - records of mortalities (both wild species and livestock - time cause of death estimated)
  - sightings of elephants, rhinos and predators ((date, locality, species, number)

These data will be summarised monthly and quarterly by supervisors in simple bar charts and maps for visual display. These will be compiled into annual activity and used as a basis for management plans for the conservancies.

Early data are being captured in data-bases which contain a few elementary analytical tools. The initial output comprises an analysis of numbers of animals seen per patrol presented as a percentage. To date this has been done only for the Torra Conservancy. It may be a useful technique for indicating direction of trends as long as effort remains more or less the same. Comparisons between species (eg elephant as a percentage of kudu) could be misleading as an increase in one species may be interpreted as a decline in the other. Data bases are held in the DEA, IRDNC and conservancies.

2.5 Road strip counts

Road strip counts were carried out for the first time in 2000 in 6 conservancies. The methodology follows Buckland *et al.* (1993) but its application to the conservancies is still being developed and reports are incomplete. A detailed report is presented in Appendix I below.

2.6 Single species monitoring

This comprises monitoring designed specifically for species of particular interest. This is reported on separately for rhinos (Appendix II) and carnivores below.

2.7 Aerial surveys

Aerial surveys have been used extensively to survey large areas in the NW. Until recently, there was no standardisation of area covered, flight routes, methodology, sampling effort etc. The approach taken by the M.E.T. is presented in Appendix III. Past aerial surveys took several forms:

2.7.1 Random reconnaissance

These were non-systematic flights over areas of interest or areas thought to be of importance and there has been at least one of these surveys almost every year since 1977. They aimed to monitor animals (particularly elephants) and covered the relevant areas according to known distributions (presumably from ground knowledge) of the animals. The information was largely used to assist managers with problem animal control and anti-poaching patrols.

The data are difficult to analyse because they seldom covered the same area (and the area covered was not mapped) and the flight lines were not systematic.

2.7.2 Total counts

Many of the surveys referred to as total counts could not have been true total counts, with search intensities of over 10km^s/minute, which is insufficient coverage to avoid missing unknown proportions of the wildlife populations. Some of the surveys were designed to follow fixed transects (eg Britz *et al.* 1986, Carter 1990). However these were not strictly adhered to and the flight lines were not always shown in the reports and even these surveys were therefore not possible to replicate. Because there was no standardisation, comparisons between surveys are not strictly possible.

It has been suggested (G. Owen-Smith *pers. comm.*) that an index of abundance could be obtained from number of animals seen per minute (as done in 1986 by Britz *et al.*). While this would be possible if more of the survey parameters had been standardised, the variability in methods preclude this option (eg. differences in height above ground result in differences in areas searched; breaking from a transect line to circle and count groups of animals reduces the area covered - though this could be accounted for if the route was tracked in detail as is now possible using GPS; flight speed varies and thus the area covered and also the "sightability" of animals vary).

Most of the major surveys of elephants have used "total count" methods. In this case they probably gave reasonable estimates of the numbers of elephants because they specifically covered areas known, through extensive field knowledge of elephant distributions and habits, to contain most if not all the elephants in the area. There is no way of telling how many were missed, however, and no measure of the precision of the count (although total counts are 100% precise, the fact that the entire area was never covered completely suggests lower precision).

2.7.3 Sample counts

Standardised systematic transect or block counts were introduced in 1998 and while it is difficult to compare the results with previous surveys, they form a rigorous basis for future aerial surveys. These are described below.

2.8 Combinations of methods

In 1975 Viljoen (Viljoen 1880) began intensive field work specifically intended to study the status and distribution wildlife in the area which combined vehicle, foot and aerial patrols to survey Kaokoland. This work was continued until 1978 and was developed into a study of elephant between 1980 and 1983 (Viljoen 1988), monitoring wildlife extensively throughout Kaokoland and Damaraland.

In 1986 a major project was initiated to obtain an understanding of the habits of elephants in northern Damaraland where they were coming into conflict with humans (becoming particularly problematical in destroying water equipment). Population monitoring was done through a combination of numerous aerial surveys and ground monitoring of individually recognised animals and herds. The aerial surveys, which continued until 1992, seldom covered the whole range of elephants in northern Damaraland. A summary of the elephant data from these surveys in the Huab Catchment Project report (Loutit? 1992?) provides a useful basis for further analysis. Details of the routes flown were sometimes described and given time and considerable input from the individuals involved in the data collection, a more detailed analysis could be produced to could be used to show the movements of elephants and other species within the various areas that were surveyed. It could be interesting to make comparisons with more recent information and perhaps to relate movements with information about the habitats (eg with NDVI indices, if available for that period).

While the distributions and numbers of animals seen in the course of aerial surveys have been reported (Loutit? 1992), the ground-based work has not been analysed (T. Hall *pers. comm.*). The information was useful for management purposes, but again it would require considerable input from the individuals who collected the data to interpret the raw data sheets and it is not clear how useful this would be except perhaps for historical information.

3. POPULATION AND DISTRIBUTION TRENDS

While details may be described for relatively small areas through ground-based monitoring methods, an overview of numbers and distributions of animals in the NW Namibia are best obtained from aerial surveys. As mentioned above, the lack of standardisation in the methods in the past presents considerable problems in using these data to draw conclusions about trends and ranges. The most important variations are as follows:

- The surveys did not cover the same areas, although there was overlap (Figs 4 - 13).
- The strata, or blocks, were seldom the same (Figs 4 - 13)
- The methods varied, although most claimed to be total counts
- The intensity of coverage varied.
- The searching intensity varied
- Flight lines were not chosen for the same reasons each survey and while not entirely arbitrary (many were selected on the basis of ground knowledge), they were not consistent.
- The flying speed may not have been the same

3.1 Analysis of data

Despite the inconsistencies mentioned above, the various data sets were used in an attempt to show population trends and changes in distributions.

Stratum boundaries were digitised as nearly as possible as could be gathered from various reports. Some of these are more accurate than others, mainly because few reports show the positions of the strata clearly and never the grid coordinates with which positions could be established. The survey strata from various surveys are presented in Figs 4 - 13 to show their relative positions. All are overlaid on the boundaries of the survey carried out by Carter (1990) to facilitate comparisons.

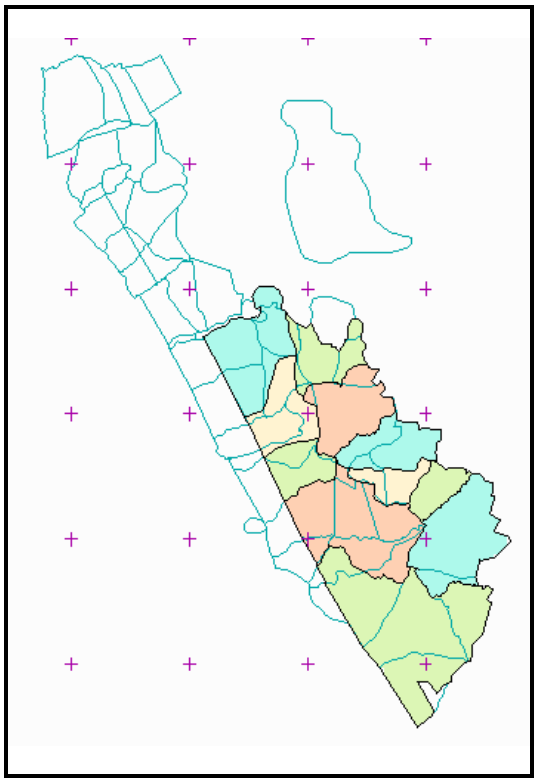

Figure 4 1977 survey strata (Visagie 1977)

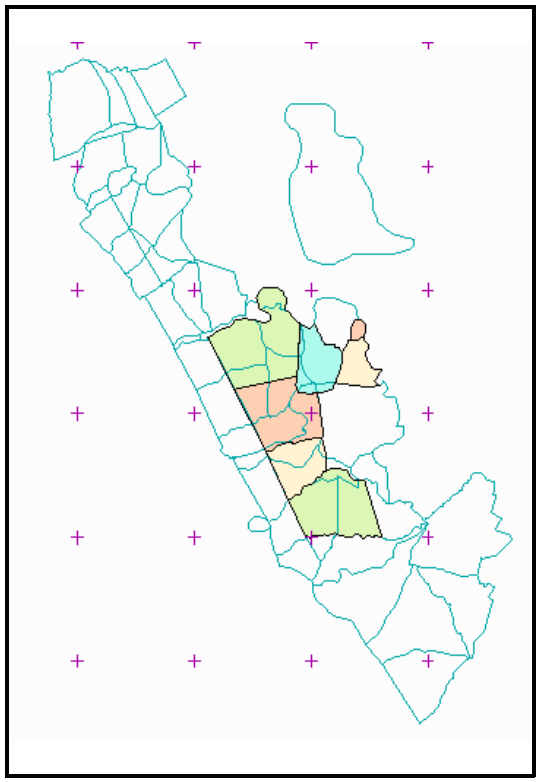

Figure 6 1979 survey strata (Mulder 1979)

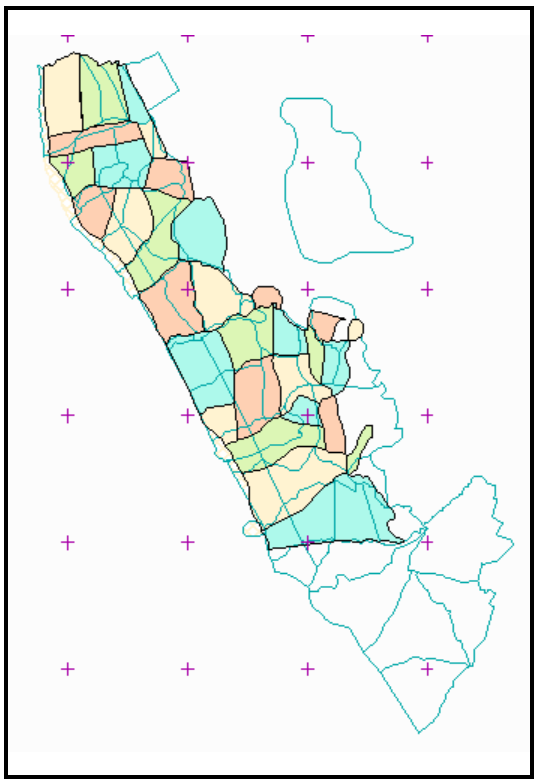

Figure 5 1982 survey strata (Viljoen 1982)

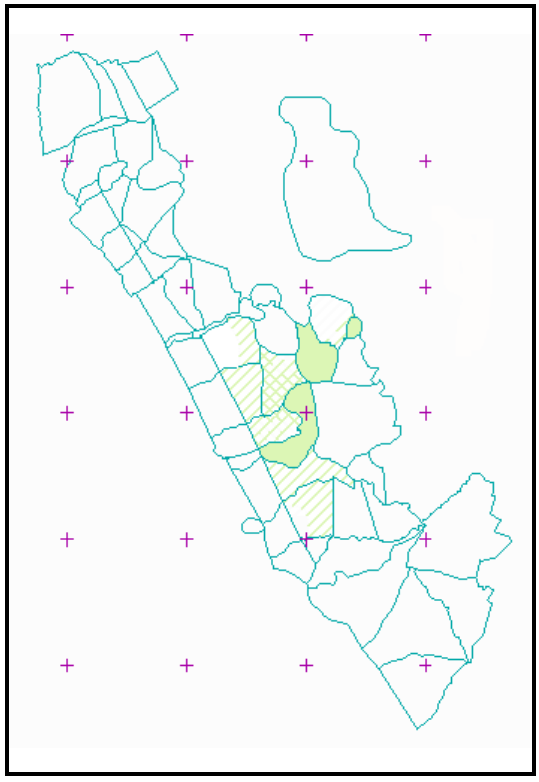

Figure 7 Area surveyed 1983 (Owen-Smith 1983)

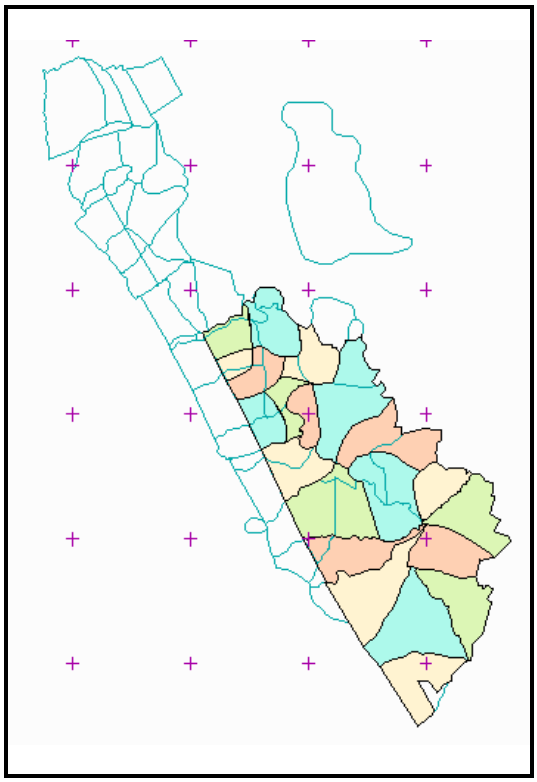

Figure 8 Survey strata 1986 (Britz *et al.* 1986)

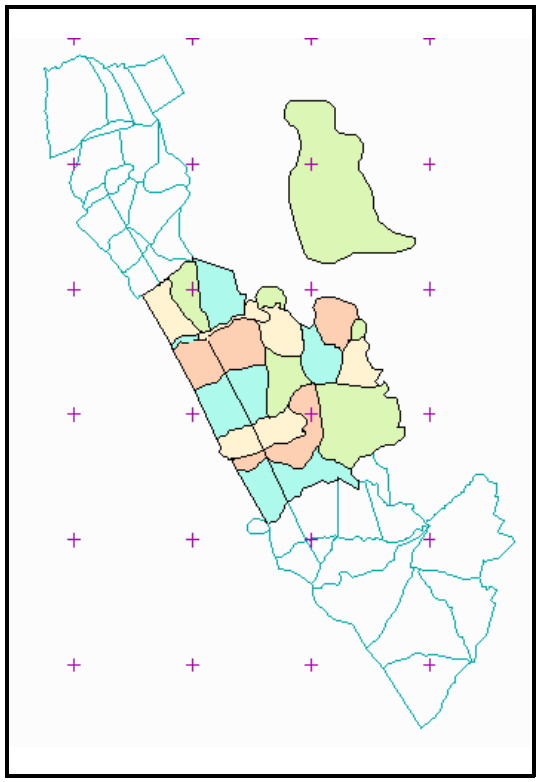

Figure 9 Survey strata 1992 (Loutit & Douglas-Hamilton 1992)

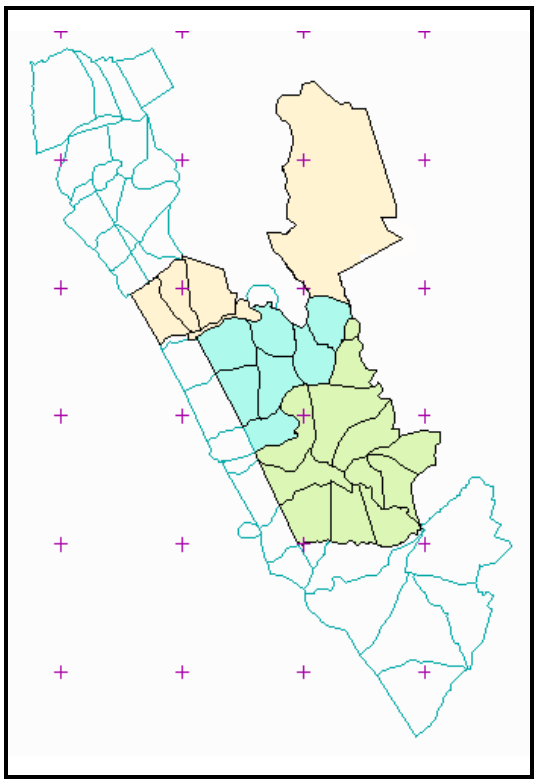

Figure 10 Survey strata 1995 (Loutit 1995)

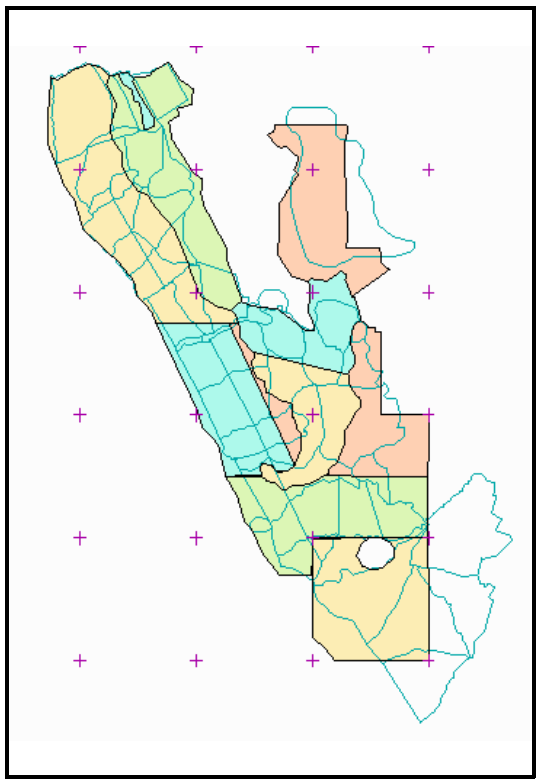

Figure 11 Survey strata 1998 (MET 1998)

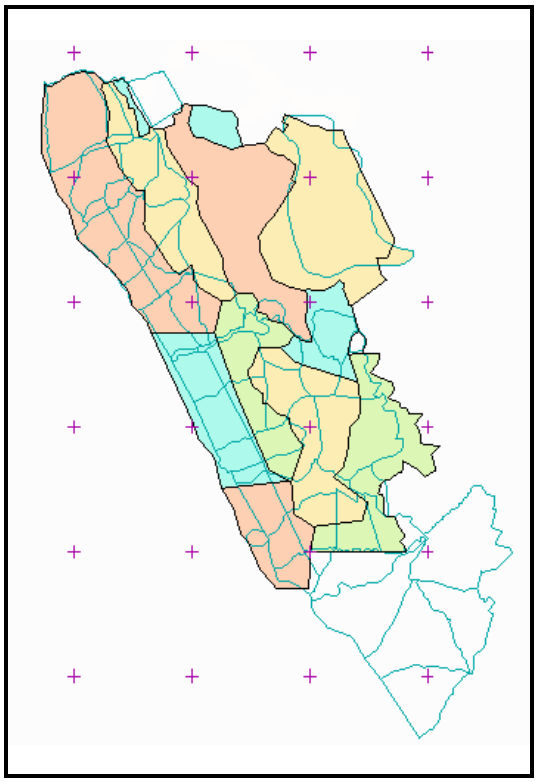

Figure 12 Suvey strata 2000 (MET 2000)

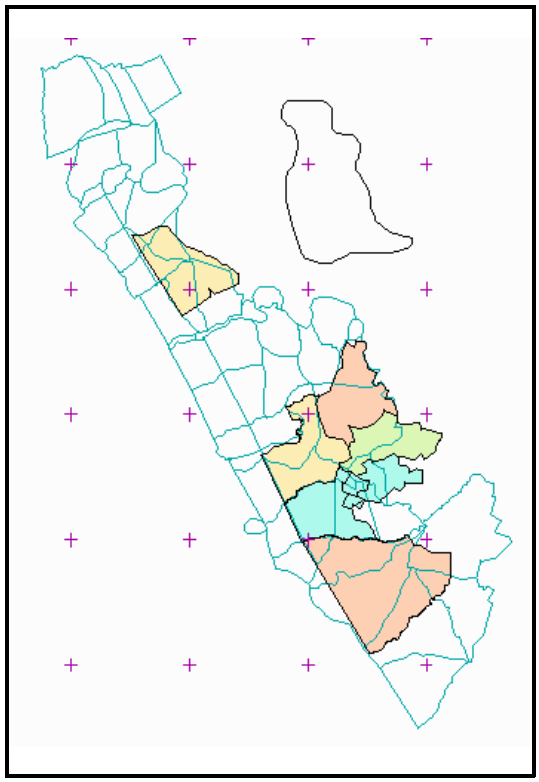

Figure 13 Conservancies surveyed 2000 (LIFE 2001)

Overlaps between surveys were established and surveys with adequate overlap selected for analysis. Since the positions of sightings were not given, numbers of each species counted in comparable blocks were used to derive density distribution maps using the centre point of each block as an average position for sightings. These were interpolated, converted to contours and plotted on maps of the area.

Maps show density distribution contours only of the areas surveyed. To give an overview of changes in distribution, the densities of all the major species were combined for each of the data sets. Additionally, maps of springbok (chosen as one of the more numerous and widespread species) provide examples of distributions of a component of the combined distribution maps.

The same data sets were used to calculate population trends from exponential regressions of the data and the statistical significance of the growth rates established. The estimates of all species from the 1998 survey are considerably higher than those from early surveys. This is likely to be a result of the increased searching intensity and therefore it is comparisons with early surveys are questionable. For this reason trend analyses were carried out on both the full sets of data (1982 - 2000) where possible and also on only earlier data (1982 - 1990).

3.2 Wildlife Distributions

Because of the poaching in the 1970s, wild animals were reduced over most of their range until the major concentration occurred south of the Huanib river, in the vicinity of the veterinary fence (R. Loutit, *pers. comm.*). This is seen in Figs 14 and 16 (note that the distributions are truncated because of the limits of the survey) and perhaps more clearly for springbok in Figs 15 and 17.

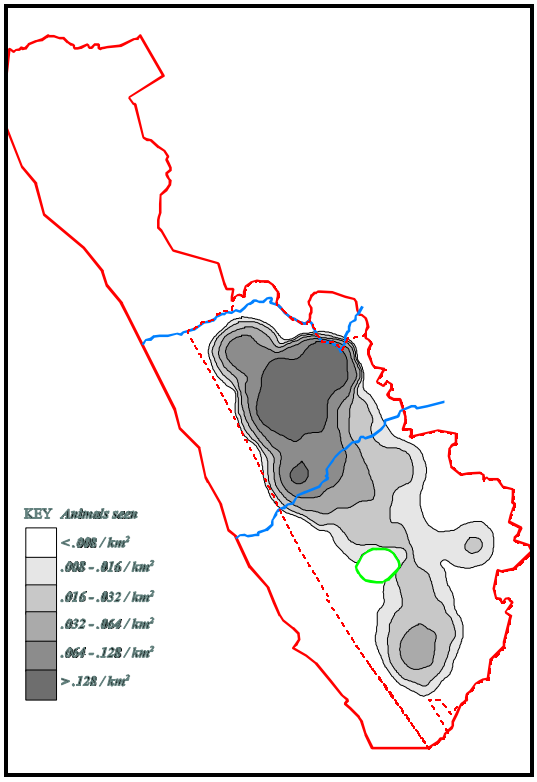

Figure 14 Distribution of major species in 1977

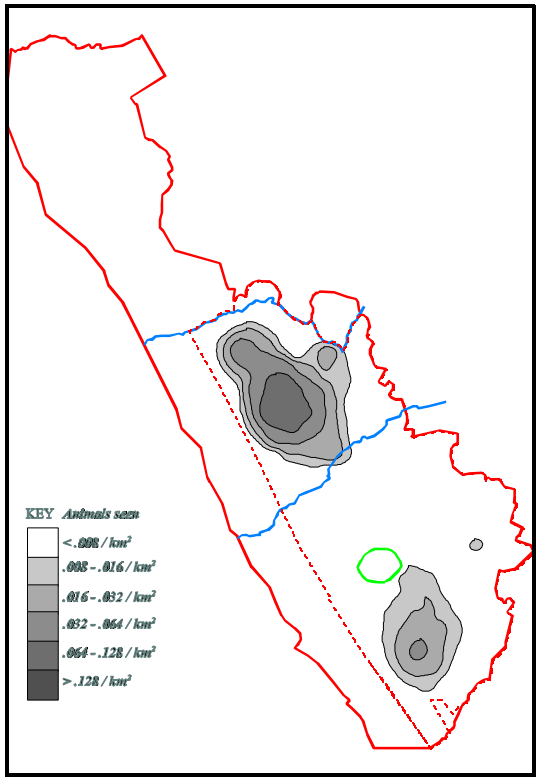

Figure 15 Density distribution of springbok in 1977

The anti-poaching efforts at the beginning of the 1980s enabled animals to expand somewhat, spreading south and west (Figs 16 to 17) and the continuing expansion of wildlife ranges through the 1980s is suggested by the maps presented in Figs 18 and 19.

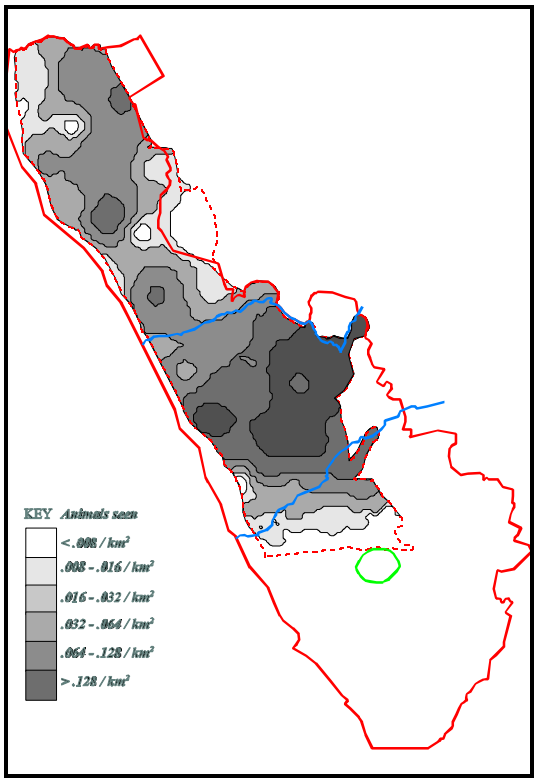

Figure 16 Distribution of major species in 1982

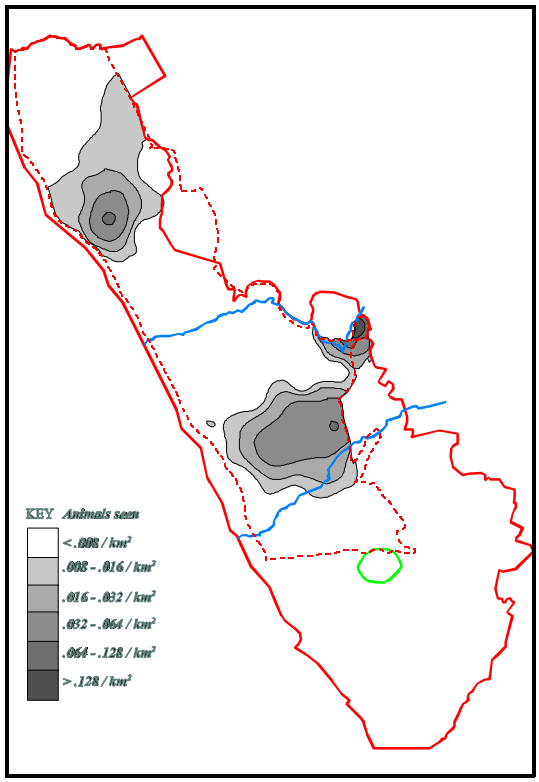

Figure 17 Distribution of springbok in 1982

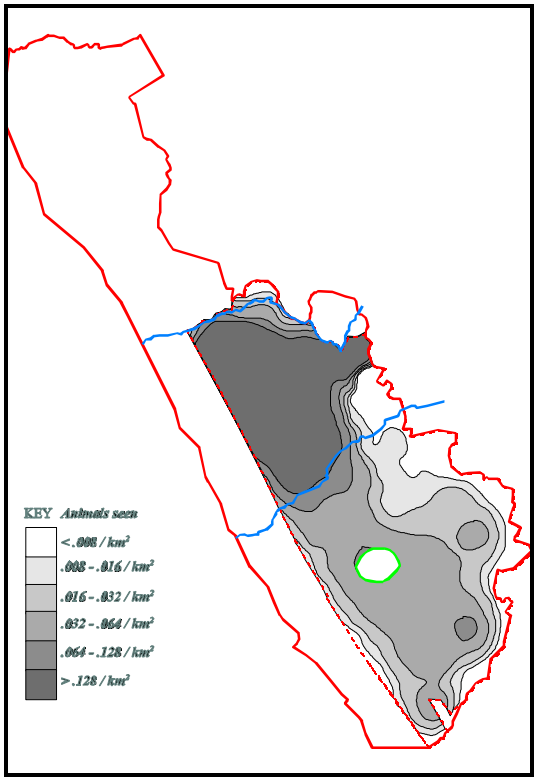

Figure 18 Distribution of major species in 1986

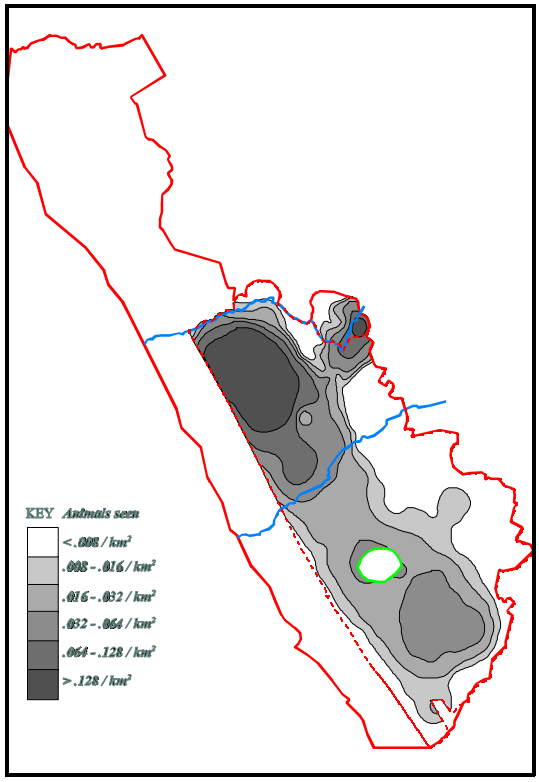

Figure 19 Distribution of springbok in 1986

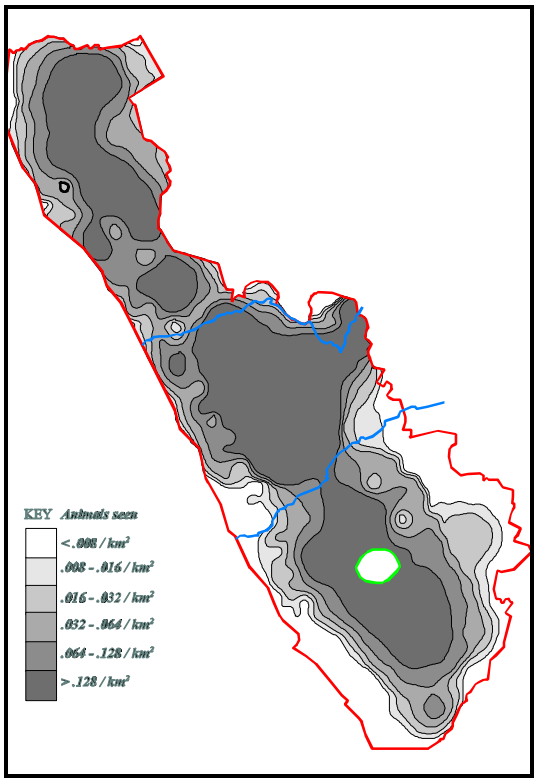

Figure 20 Distribution of major species in 1990

The distribution maps (Figs 20 and 21) suggest that by 1990, animals had increased in numbers and range even south of the Brandberg and in the north over most of the former Kaokoland.

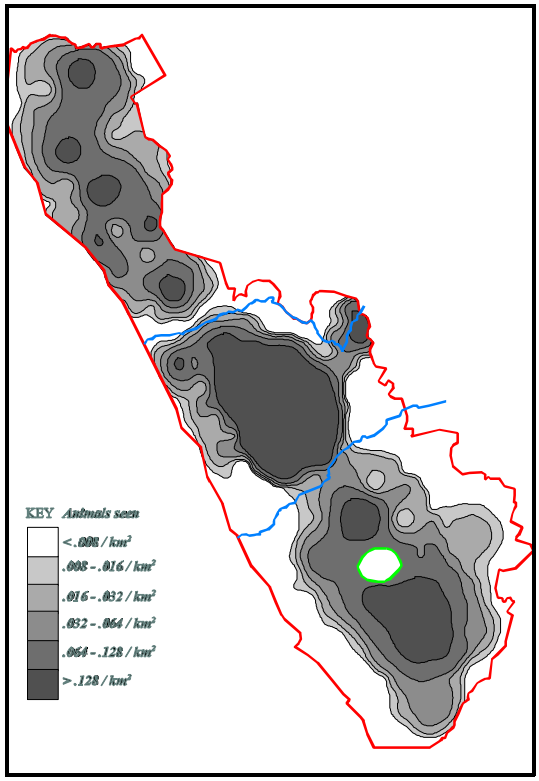

Figure 21 Distribution of springbok in 1990

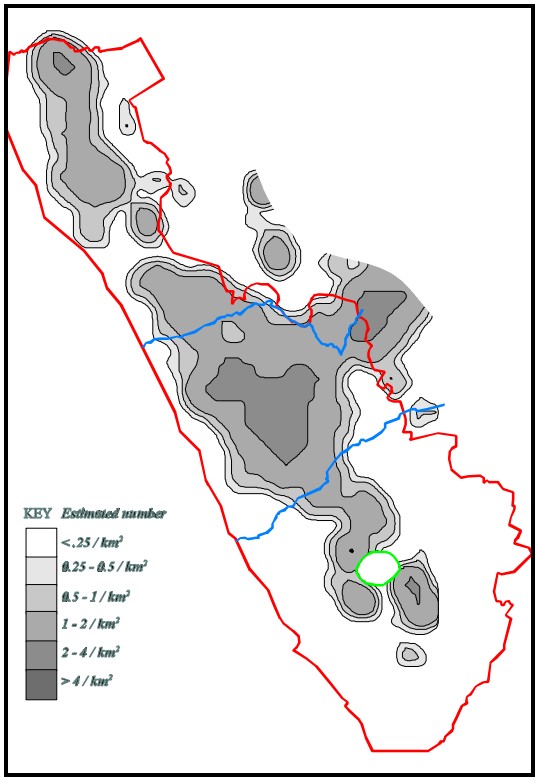

Figure 22 Distribution of wildlife in 1998 & 2000 combined

It should be remembered that these distribution maps were based not on positions of animal sightings but on the centre points of the survey strata and are likely to be misleading to some unknown extent. They do appear to give an intuitively reasonable picture of the situation, but it is likely that while showing where main concentrations of wildlife occur, the maps exaggerate the range and it is more likely that at least the 1990 range more closely resembled the distribution shown for 2000 in Fig. 22 (note, however, that the scale of densities is considerably higher in 2000 than those for earlier surveys).

3.3 Trends

The numbers of most of the species counted by the various surveys also seem to follow what is know about populations over the past 20 years, *viz* a decline until the early 1980s followed by an increase that continues today (Figs 23 - 30).

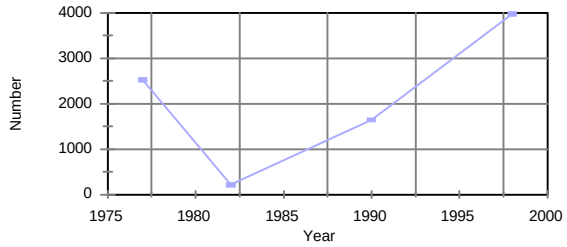

Figure 23. Numbers of springbok in Kaokoland

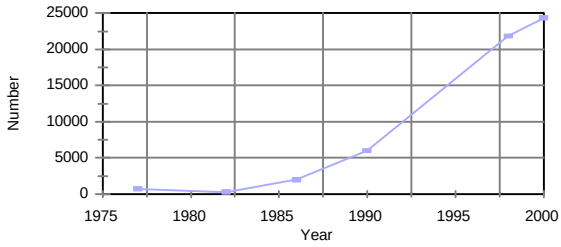

Figure 24. Numbers of springbok in Damaraland

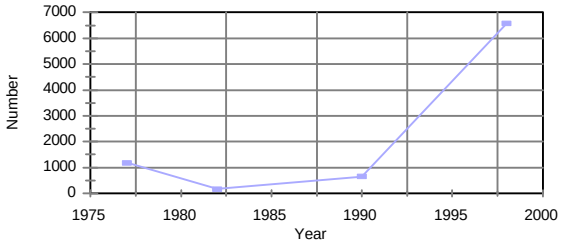

Figure 25. Numbers of oryx in Kaokoland

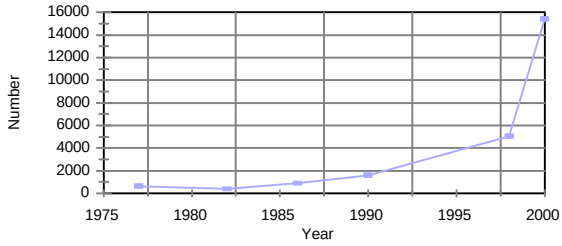

Figure 26. Numbers of oryx in Damaraland

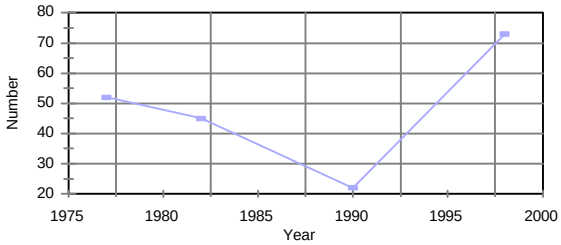

Figure 27. Numbers of giraffe in Kaokoland

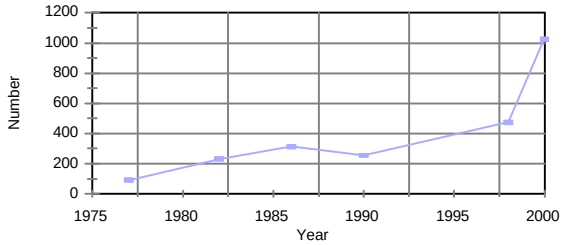

Figure 28. Numbers of giraffe in Damaraland

The variability in numbers of zebras shown in Fig. 29 could be an artifact of the survey - for example surveying when zebras have moved into the mountains and are less easily counted.

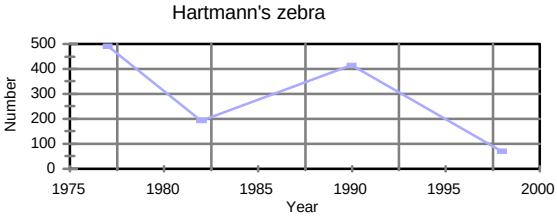

Figure 29. Numbers of mountain zebra in Kaokoland

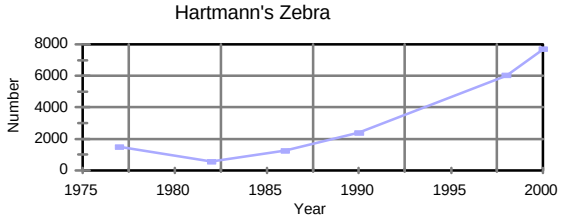

Figure 30. Numbers of mountain zebra in Damaraland

Unfortunately the data have to be treated with some caution because, as mentioned above, they are not strictly comparable. For example, the searching intensity was very low in the early surveys (around 10km^2 / minute), resulting in under-counting numbers of animals. In the recent sample counts an area of 1.6km^2 / minute was the average (Table 2) and it is likely that fewer animals were missed in the 1998 survey than previously.

Table 2. Searching intensities

Year	Search intensity - km^2/minute
1979	25.98
1982	10.59
1986	10.44
1990	9.98
1992	11.02
1998	1.63

None of the data from surveys of Kaokoland showed statistically significant trends. The data suggested significant growth rates for springbok, oryx and Hartmann's zebra in Damaraland between 1982 and 2000. However with the exception of zebra, population trends were not significant when the most recent data were removed from the analysis.

Table 2. Significant population trends in Damaraland

#Data set	Period	SPECIES	growth rate	95% range %	t
Viljoen	1982-2000	Springbok	25.6%	12.2 - 40.8	6.3047**
Viljoen	1982-2000	Oryx	20.1%	12.5 - 28.1	8.9962**
Viljoen	1982-2000	H. zebra	15.1%	11.8 - 18.5	15.2056***
Viljoen	1982-1990	H. zebra	19.7%	5.3 - 36.2	17.7601*
Mulder	1982-2000	Oryx	15.7%	8.1 - 23.8	9.2267*
Mulder	1982-2000	H. zebra	21.6%	4.1 - 42.0	15.9440*
Mulder	1982-1990	H. zebra	14.1%	4.1 - 25.1	6.2067*

#Data set refers to the numbers obtained from blocks equivalent to those used by Viljoen or Mulder

3.4 Elephant Surveys

The objective of many of the aerial surveys was to count elephants and although they probably missed a proportion of the population because of the low searching intensity, they were largely designed to count intensively those areas known, through field experience, to contain most of the animals or to include most of their range.

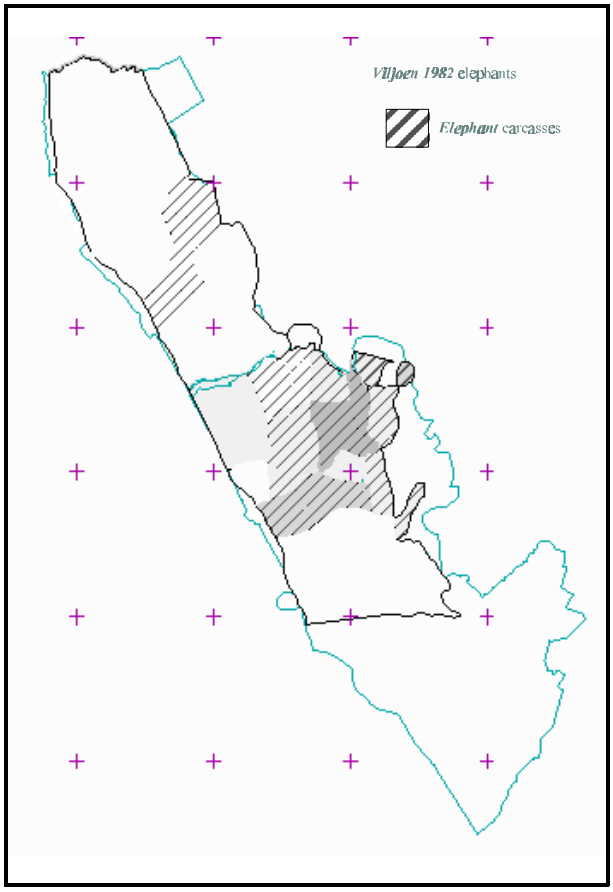

Figure 31 Elephants 1982

Evidence of a decline in the range of elephants is provided by the survey carried out by Viljoen in 1982. The map in fig. 31 is somewhat misleading as all survey blocks in which elephants were seen are shaded even though elephants were unlikely to have been spread throughout the blocks. However, the occurrence of carcasses (cross-hatched areas) in areas where elephants are no longer found indicates a decrease in the range.

Since the 1980s, the elephant counts have shown a consistent increase in the population (Fig. 32). This increase is statistically significant at 6.2% per annum (between 3.5% and 9%) between 1982 and 1998. Leaving out the most recent data gives a statistically significant increase of 5.2% per annum (between 1.7% and 8.7%). In normal conditions elephant populations seldom increase at more than about 6% per annum and it is possible that immigration from Etosha has supplemented the reproductive recruitment of elephants living in the harsh environment of Damaraland.

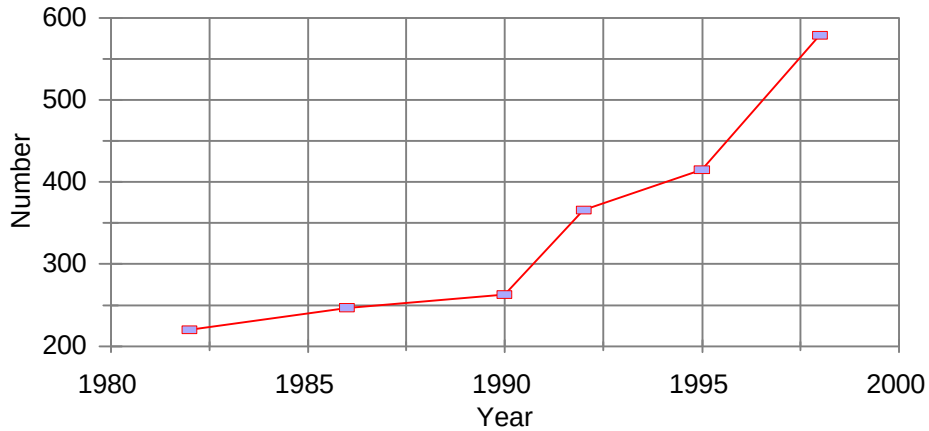

Figure 32 Elephant numbers in North Western Namibia

3.5 Hobatere Surveys

A further problem with comparisons and attempts to look at trends is the fact that surveys have been examining populations which are not closed - in fact the animals are highly mobile and likely to move rapidly in response to seasonal changes. This is illustrated by successive surveys of Hobatere (eg. Cilliers 1986, Cilliers 1987, Vinjevold 1988, Leggett 2001) where there have been more surveys done more intensively than elsewhere in Damaraland and where the numbers of animals counted vary considerably (Table 3). However, this variability not likely to be entirely due to movements in and out of the area, although this is a factor, nor to changes in population size, but probably also in part a result of inconsistent survey techniques. Most of these surveys have been total counts with transects fixed at 1km apart. This is rather far apart for a total count and animals are likely to have been missed. Survey intensity for these counts varies from 26km^2/minute in 1983 and down to 0.97km^2/minute in 1986 with a considerable and variable range between. However the surveys are useful for management of the area in providing indications of the seasonal changes in numbers and distributions.

Table 3. Numbers of animals counted in Hobatere

Date	Springb	Zebra	Giraffe	Eleph.	Warthg	Oryx	Ostrich	Eland	Kudu
1979		17	37		16	14			
1983 July	63	81	41	22		50	1		5
1983 May	0	0	6	0		33	0		
1984 Aug	0	31	21	9		14	0		
1986 May	66	227	70	29	0	90	9	0	7
1988 June	14	125	58	15	0	13	2	19	2
1988 June	36	283	108	28	-	68	-	29	12
1988 Aug	55	210	74	35	5	129	2	0	4
1988 Mar	1	231	59	6	9	55	11	0	1
1990	63	277	63	1		47	9		19
1999 Apr	148	523	73	11	5	112	5	97	61
1999 Apr	152	1137	121	24	-	506	9	144	50
2000 Apr	18	121	24	8	-	35	4	10	12
2000 Apr	55	531	109	10	4	186	8	127	15

3.6 Conservancy Data

Finally, it is quite interesting to compare the estimates of numbers of animals in the conservancies from the 2000 aerial survey with those estimated by the road strip counts. (Tsiseb was omitted from the table because that area was not surveyed by air). With the exception of estimates for mountain zebra, the aerial estimates were consistently lower than those from the road counts.

The analyses of the road strip counts had not be finalised at the time of writing this report and several had not been corrected for strip width. Strip widths had been measured for Huab and Tsiseb Conservancies at an average of about 400m but a width of 800m had been guessed at for all the other conservancy counts from which the estimates were calculated. These were therefore likely to be underestimates. In the case of mountain zebra, numbers were over-estimated from the count because animals seen on the sides of the mountains were included in the survey strips.

This downward bias in aerial surveys doesn't result from biassed coverage and it is theoretically possible to eliminate it with correction factors. However the road counts are also biassed, and the direction of the bias is seldom known, so it is not possible to use them at present to provide correction factors for the aerial surveys.

Table 4. Comparison between road strip counts and aerial surveys for estimates of wildlife numbers in conservancies in 2000

	Springbok		Oryx		Ostrich		Mtn zebra		Kudu		Giraffe	
	Road	Aerial	Road	Aerial	Road	Aerial	Road	Aerial	Road	Aerial	Road	Aerial
Huab	436	0	116	0	46	0	0	0	237	0	0	0
Doronawas	1528	1026	580	347	67	65	579	726	0	0	75	0
Torra	7489	2646	1395	492	1079	195	631	440	573	16	37	0
Purros	7756	1574	1719	1905	1143	409	261	223	0	0	52	0
Khoadi hoas	1246	49	742	281	97	149	152	464	540	0	163	215
Mean	3691	1059	910	605	486	164	325	371	270	3	65	43

4. RECOMMENDATIONS

A plan containing recommendations for coordinated monitoring of wildlife in north-western Namibia was developed from discussions between stakeholders at a workshop. However, a number of aspects that became apparent from the review of past surveys and that should be considered in future monitoring programmes are as follows:

- detailed maps of sampling areas should be provided with each report
- maps showing transects/routes flown, driven or walked should be provided with each report
- raw data should be provided with each report in case of a requirement for further analysis and should include locations of sightings and numbers seen
- time spent on each sampling transect or route must be recorded
- past survey strata should be taken into consideration in designs of surveys
- design should result in a "flexible" output - data should additionally be applicable to areas other than the original survey boundaries. For example, aerial survey data should be able to provide information for specific areas of interest such as conservancies. Similarly road strip count data should be designed with an overview of the area in mind.
- surveys should be designed to provide an estimate of repeatability (95% confidence limits)
- surveys should be designed to avoid bias. For example sampling transects/selected roads should be oriented across and not along ecological gradients
- surveys should be done in as rigorous a manner as possible, eliminating as many sampling variables as possible. For example if a radar altimeter is not available for a transect aerial survey, block counts should be used; speeds should be standardised; for ground counts records of effort must be made etc.

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