RESEARCH

Namibia's elephants—population, distribution and trends

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Abstract

Namibia's elephants extend across the north of the country. They occur in six main areas of the known Namibian range—the north-west, Etosha National Park (NP), Mangetti National Park, northern Kavango, Khaudum National Park/Nyae Nyae Conservancy and Zambezi Region. Seasonal changes in distribution are related to water availability. There are movements of elephants between Namibia and its neighbours, particularly Botswana, and mainly from Zambezi Region. The largest populations are found in the north-east of the country, in Khaudum/Nyae Nyae and Zambezi Region. Densities are very low in the extremely arid north-west and Etosha National Park but have recovered from historical over-hunting that almost exterminated them.

The estimated rate of change for the north-west population is 3.86% per annum between -0.08% and 7.95%), which is not statistically significant. Since 1998, surveys have shown that the elephant population has been increasing slowly in Etosha National Park at an estimated annual rate of 1.75% (between 0.65% and 2.87%). The trend is statistically significant. There has been a consistent and significant increase in the Zambezi population at an estimated and biologically realistic annual rate of 4.76% (between 2.73% and 6.84%) since 1995. This trend is statistically very highly significant. The population of elephants in Khaudum National Park and Nyae Nyae Conservancy has increased at a very highly significant rate of 4.85% (between 3.24% and 6.48%).

As a total population, Namibia's elephants have been increasing at a rate of 5.36% (between 4.20% and 6.53%) since 1995. This is also statistically very highly significant.

Résumé

Les éléphants de Namibie sont présents dans tout le nord du pays. Ils sont répartis dans six zones principales de l'aire de répartition namibienne connue: le nord-ouest, le parc national d'Etosha, le parc national de Mangetti, le nord de Kavango, le parc national de Khaudum/Nyae Nyae Conservancy et la région de Zambezi. Les changements de cette distribution selon les saisons sont liés à l'existence d'eau. Il y a des mouvements d'éléphants entre la Namibie et ses voisins, en particulier le Botswana, et principalement depuis la région de Zambezi. Les populations les plus importantes se trouvent dans le nord-est du pays, dans la région de Khaudum/Nyae Nyae et de Zambezi. Les densités sont très faibles dans les zones extrêmement arides du nord-ouest et d'Etosha, mais se sont rétablies de la sur-chasse historique qui les a presque exterminés.

Le taux de changement estimé pour la population du nord-ouest est de 3,86 % par an (entre - 0,08 % et 7,95

%), ce qui n'est pas statistiquement significatif. Depuis 1998, des enquêtes ont montré que la population d'éléphants augmente lentement dans le parc national d'Etosha à un taux annuel estimé à 1,75 % (entre 0,65 % et 2,87 %). La tendance est statistiquement significative. Il y a eu une augmentation constante et significative de la population de Zambezi à un taux annuel estimé et biologiquement réaliste de 4,76 % (entre 2,73 % et 6,84 %) depuis 1995. Cette tendance est statistiquement très significative. La population d'éléphants du parc national de Khaudum et de la réserve de Nyae Nyae a augmenté avec un taux très hautement significatif de 4,85 % (entre 3,24 % et 6,48 %).

En tant que population totale, les éléphants de Namibie ont augmenté à un taux de 5,36 % (entre 4,20 % et 6,53 %) depuis 1995.

Introduction

Recently there has been concern about the decline in African elephant populations caused by an upsurge of illegal hunting for ivory which began, continentally, in about 2007 (Chase et al. 2016). This concern underlies the process that led to the reclassification of elephants as Endangered in the 2021–1 IUCN Red List of Threatened Species. However, the rate of change in elephant populations is not uniform across range states within Africa or even within those range states. The present paper sets out to report the distribution, numbers and trends and in one country, Namibia, south-western Africa.

According to the African Elephant Database (AED) 2016, the present distribution of elephants in Namibia is as shown in Figure 1 (Thouless et al. 2016). It can be seen that elephants are at present restricted to the north of the country. Figure 1 also makes it clear that elephant range in the far north-east of the country is contiguous and probably continuous with elephant range in adjacent countries—Angola, Botswana, Zambia and Zimbabwe.

Elephants in the known range within Namibia can conveniently be separated into six components (loosely referred to here as populations) that are treated as distinct units for management purposes. These have always been surveyed and reported separately or as distinct units within a nation-wide survey. Figure 2 illustrates the relevant areas, which are the basis for population estimates reported here. The boundaries represent the maximum extent of locations of elephants from recent surveys or from satellite telemetry.

The approximate number of elephants (rounded off to reflect uncertainty) in each area is shown in Table 1 (See Tables at end of manuscript). The elephant densities in Table 1 are crude densities calculated from the numbers and areas in the Table. East-west differences in density are apparent: Zambezi Region (6) has an average elephant density of over 1 elephant/km^2, while elephants in the large range in the north-west (1) have only a fiftieth of that density on average. These differences are largely the result of ecology: the north-east (6), where annual rainfall averages over 550mm, supports savanna woodland, while the western extreme of the north-west is desert, with less than 30mm. Anthropogenic factors also play a part in the variation. For example, Etosha National Park (NP) (2) has a history of protection from the early 1900s, while the small areas of range (Mangetti area and northern Kavango: 3 and 4) in Kavango region are in agricultural areas.

Historically, elephants were probably distributed across Namibia wherever there was surface water—from the Namib Desert (Kinahan et al. 1991; Viljoen 1987) in the west through Etosha and east to the more productive woodlands of the north-east. The original size of the population is not known, but it is thought that there was a major decline during the 19th century, largely due to ivory hunting (Bollig and Olwage 2016). Viljoen (1987) speculates an over-hunting outbreak in the north-west from 1890 to the early 1900's. By 1881 they had been exterminated in Etosha and Namibian elephants were limited to small numbers in north-western and north-central Namibia (Hahn 1925; Nelson 1926, Shortridge 1934). Wartime poaching during the 1980s (Owen-Smith 1996; Ramey and Brown 2019) kept the numbers of elephants in the north-west very low and the increase since then has been very gradual. The arid environment cannot support large populations but there are additional factors that prevent greater increase in numbers—reproductive rates are low, and natural mortality is higher than in less harsh conditions. Elephants started

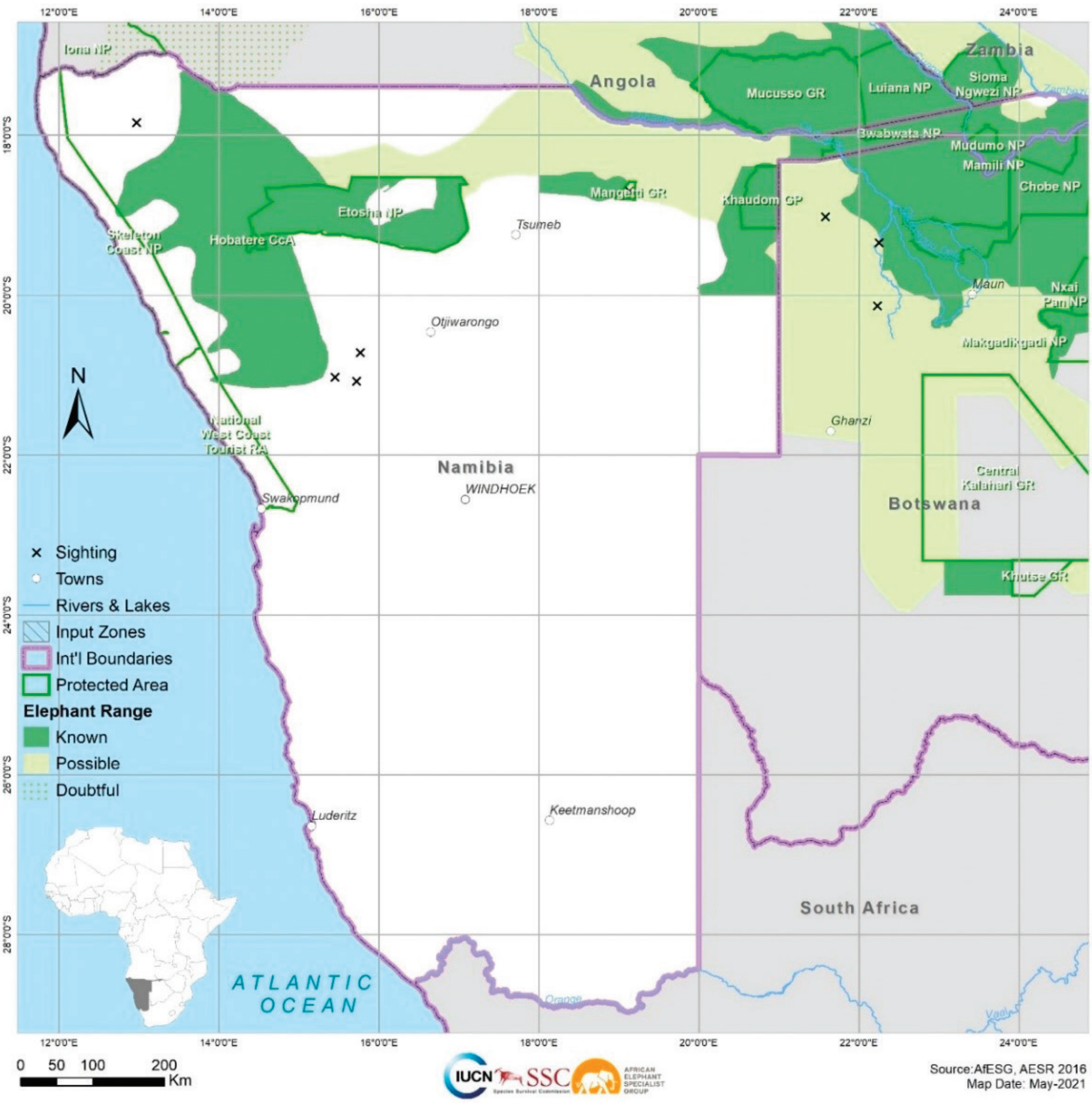

Figure 1. Known and possible ranges of elephants in Namibia (Reproduced from Thouless et al. 2016).

returning to Etosha in the 1950s (Lindeque 1988). At this time, waterholes were being installed for wildlife. It is likely that these not only attracted elephants into the Park but also allowed them to survive in the area through dry seasons and droughts. Regular monitoring dates from around this time. (Etosha was gazetted as a national park in 1967).

In Namibia, elephants have been counted using a variety of aerial and ground-based methods, mainly by the Namibian Ministry of Environment, Forestry & Tourism (MEFT) or its predecessors. These have included reconnaissance flights (Owen-Smith 1983), total counts, and transect or block sample counts while on the ground, wild animals are monitored through methods such as the Event Book System (Stuart-Hill et al. 2005) and ground transects. Aerial counts have provided estimates since around 1950 but have not always covered the same areas or used the same methods, so many early surveys are not strictly comparable. More recently however, internationally accepted and consistent standards (Craig 2012; CITES 2020) are employed for Namibia's aerial surveys using

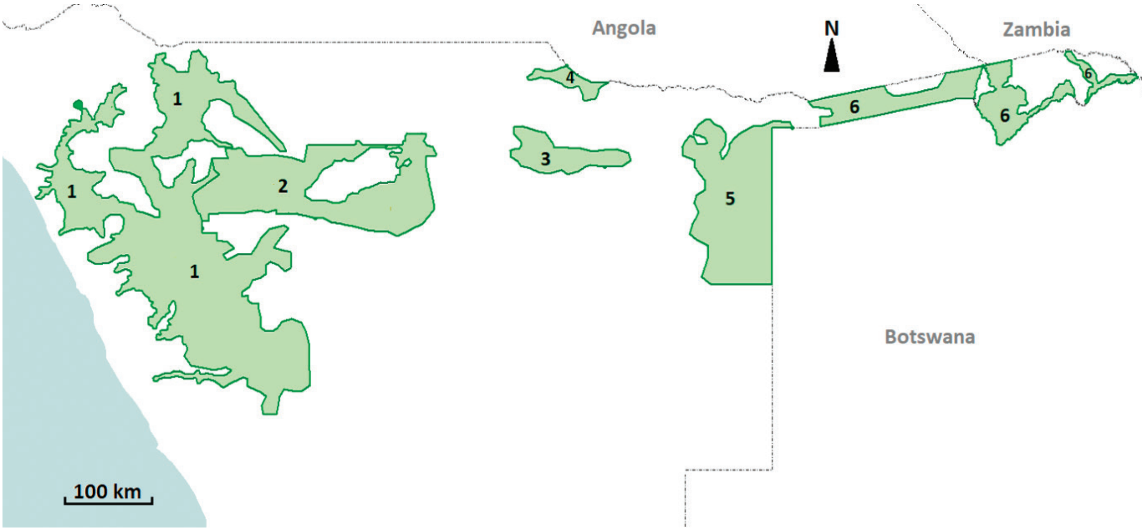

Figure 2. Components of elephant population distributions (numerical labels refer to Table 1).

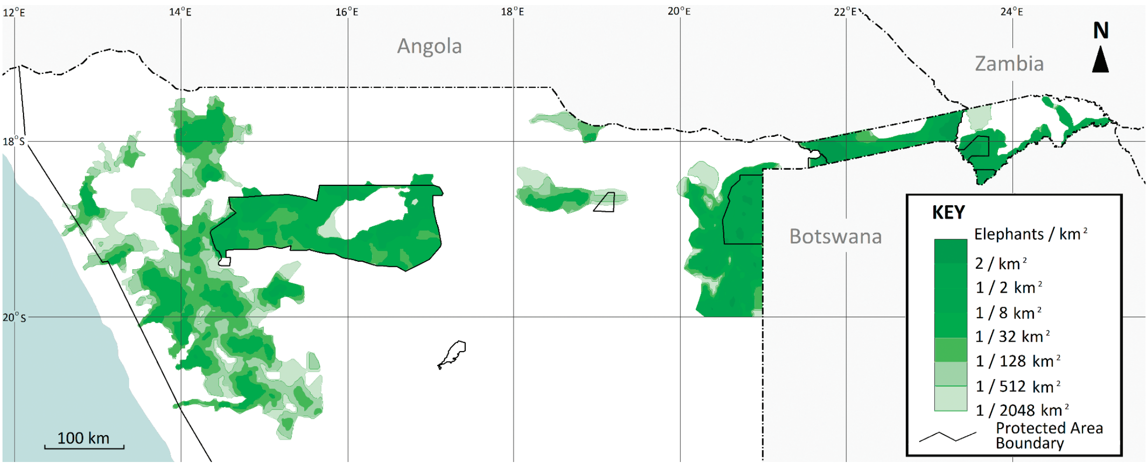

Figure 3. Density distribution of elephants/dry season.

transect or block sample counts (Norton-Griffiths 1978; Jolly 1969; Gasaway et al. 1986). These provide estimates of numbers that can be used to determine population trends and distributions.

Distribution

Knowledge of distribution is important for determining areas of range, understanding seasonal and cross border movements, prioritizing management and for planning further monitoring.

Methods

Distributions of elephants have been described by density contour maps constructed using a combination of dry season (May to October) aerial survey results and satellite telemetry locations. These maps are based on those prepared for the Namibian elephant conservation and management plan (MEFT 2020).

Sightings of elephants during aerial surveys from 2011 to 2019 provided the basis for the density distribution map (Fig. 3). Daily locations from dry season satellite tracking, where available, were added to improve peripheral detail where survey sightings were sparse or where there had been no

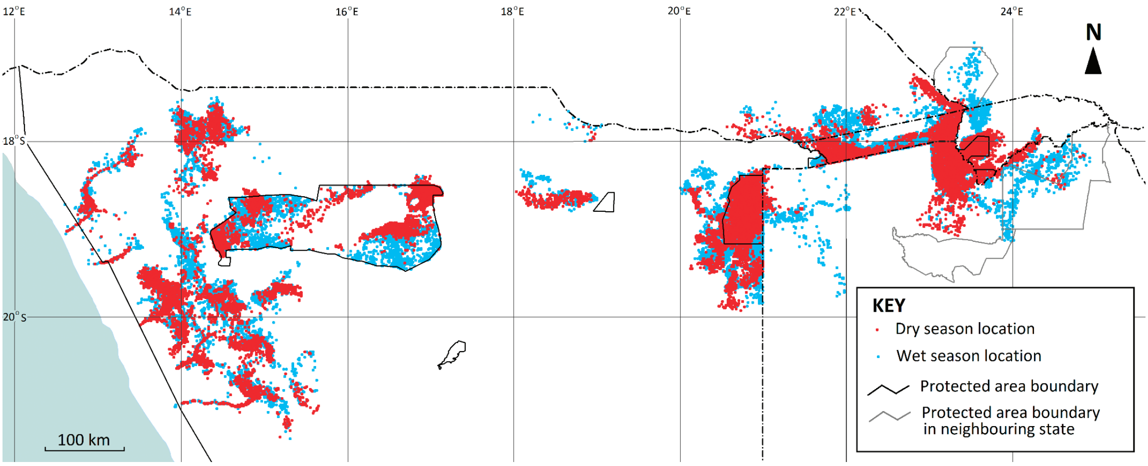

Figure 4. Seasonal Distribution: dry (red dots) overlaid on wet (blue dots) sightings.

survey. Satellite tracking data further provided the information for illustrating range expansion during the wet season (Fig. 4).

Tracking data included the wet and dry season locations of collared elephants made up as shown in Table 2.

Density distribution mapping

Densities for contour mapping were calculated from recent aerial survey results using sightings weighted by number seen and sampling intensity. These are summarized into a grid and filtered by moving averages and voronoi polygons to give smoothed contours. Satellite telemetry sightings were simplified to contain only one sighting for each day of tracking and separated into wet and dry season records. The survey grid and the telemetry grid were combined by addition, then divided by a constant to reduce the number in the resultant grid to the correct population size.

Seasonal distribution mapping

Population estimates from which densities can be derived are limited to the dry season when aerial surveys are conducted, and the wet season satellite tracking data lack information for some areas. Nevertheless, comparing the extent of wet season locations with that of dry season locations provides an estimate of the wet season range relative to the dry season range (MEFT 2020).

To do this, the tracking data set for each individual was simplified to contain only one sighting for each day of tracking. Sightings for all individuals were combined into one file. The range was divided up into polygons to which estimates of numbers could be allocated based on the most recent survey data. Sighting locations were overlaid on the polygons so that a determination could be made for the polygon in which it occurred. The points were then allocated weights so that the sum of the weights in a polygon equalled the estimate of elephants within the polygon. Points were added to a grid and filtered in the same way as for the aerial survey sightings.

For the purposes of comparison, the areas of the distributions are taken to be the number of grid cells containing one or more locations when the cell size is two minutes on a side (13 km^2 at 18.5° S).

Countrywide distribution

The distribution of Namibia's elephants across northern Namibia presented in Figure 3 corresponds to the "known" distribution reported to the IUCN 2016 African Elephant Status Report (AESR) (Thouless et al. 2016) shown in Figure 1.

The AESR also shows "possible" range filling much of the rest of the north central parts of Namibia, in which occasional sightings have been made. There have been no systematic surveys in most of that range although a survey in 1998 (Craig 1999) covered the area north of Etosha National Park to the Angola border. There were no sightings of elephants then and it is likely that the very few elephants that are there only visit the area fleetingly, amounting to an occupancy on average of fewer than one in 2,000 km^2 (less than the outer contour of the density distribution map in Fig. 3). None of the elephants fitted with collars have been tracked into this range to date.

Although there are records of sighting of individual animals or groups in areas well outside the usual range, there is otherwise little evidence of range expansion. The AESR (Thouless et al. 2016) reports 112,471 km^2 of "known" range in 2016 while the outer limits of range calculated from survey and telemetry data shown in Figure 3 covers 98,000 km^2. This merely illustrates the difficulty of measuring an area of range which grades into extremely low densities at the edge so that the true extent is indeterminate. Any estimate of the maximum area is necessarily speculative. Apparent expansion of the range may represent real changes, or increase in density, and hence detectability, within pre-existing range.

Seasonal distribution changes

As in other parts of the continental elephant range (e.g. ULG 1995), there are seasonal differences in the distribution of elephants in Namibia (Leggett 2006). Dry season distribution is smaller than wet season distribution with which it mostly overlaps, although there are small areas which are exclusively dry season range. Table 3 summarizes the wet and dry ranges as exclusively dry range, overlap and exclusively wet range for each regional range component.

The highest densities of elephants are reached during the dry season when they are aggregated in response to reduced water and resource availability. In Zambezi Region, some aerial surveys have recorded local densities of >8 elephants/km^{-2}. Such levels may be temporary as animals move around, reducing the mean density at a point; the aerial surveys are, after all, based on the locations of animals on a single day. However, the density distributions illustrated in Figure 3 are based partly on locations throughout the dry season over several years and still represent impressive densities: in Zambezi Region, the 2 km^{-2} density contour contains an area of 2,100 km^2. Increased range during the wet season obviously would result in lower overall densities: for example, in Zambezi Region, with an increase of 42%, the average density must be (1/1.42). 100% = 70% of its dry season value.

Figure 4 shows the distributions of dry and wet season telemetry locations for all collars (see Table 2) in the data set. Locations outside Namibia have been included in the map.

Population trends

Methods

The populations reported on here (MEFT 2020) each appear a reasonable fit to a model of exponential growth. While the real situation could be different, e.g. with per capita increase slowly declining or setbacks such as illegal hunting disturbing the underlying trend, there is insufficient information to justify a less parsimonious approach for any of these populations.

Regression parameters were calculated using MS Excel© Analysis tools (MEFT 2020). The F ratio is from an ANOVA performed to determine the significance of the variance due to regression.

The population trends are presented with lines above and below (here coloured red) to represent the 95% range within which the true numbers would lie.

Countrywide estimates

Because there are fewer surveys in some areas than others and only a few cases of surveys being carried out simultaneously countrywide, it is necessary to combine some of the estimates from consecutive years to provide enough points to conduct a trend analysis for the entire country. These are summarized in Table 4.

There is a clear upward trend in the overall number of elephants since the 1990s.

The estimated rate of population increase p.a. for Namibia's elephant is 5.36% (between 4.20% and 6.53%). The trend is statistically very highly significant ($F=225.29$, $p = 0.00064$***).

Although the countrywide trend is positive, the rates vary from west to east. Tables in each of the following sections present the sources of survey data with as many estimates of elephant numbers as possible even where they are not strictly comparable. Data that are not used in trend analyses are shown as open circles on the graphs.

North-west Namibia

Information about elephant numbers in north-west Namibia is patchy largely because of the difficulties of conducting surveys in the area due to the terrain and the extremely low densities of elephant (see Table 1). A variety of methods have been used over the

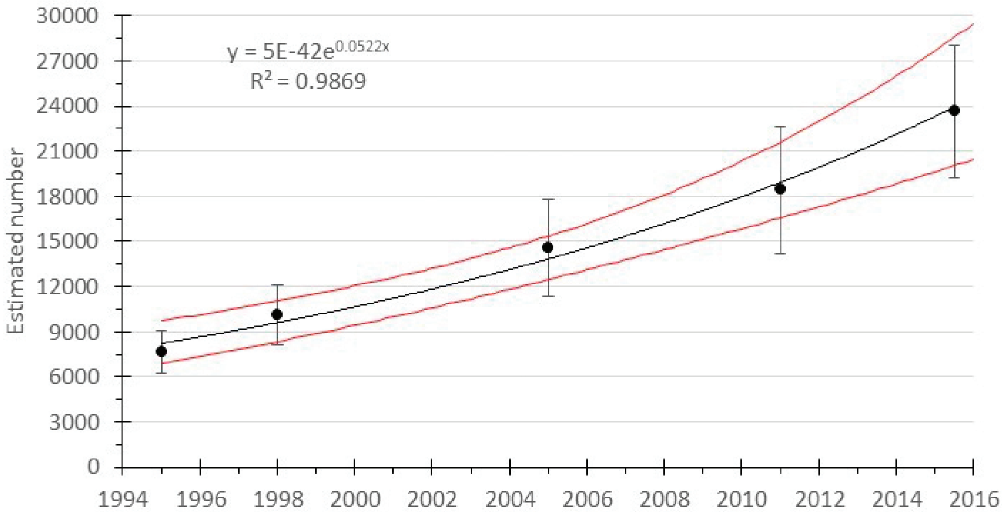

Figure 5. Elephant population trend for Namibia (red lines show the 95% confidence limits on the trend line).

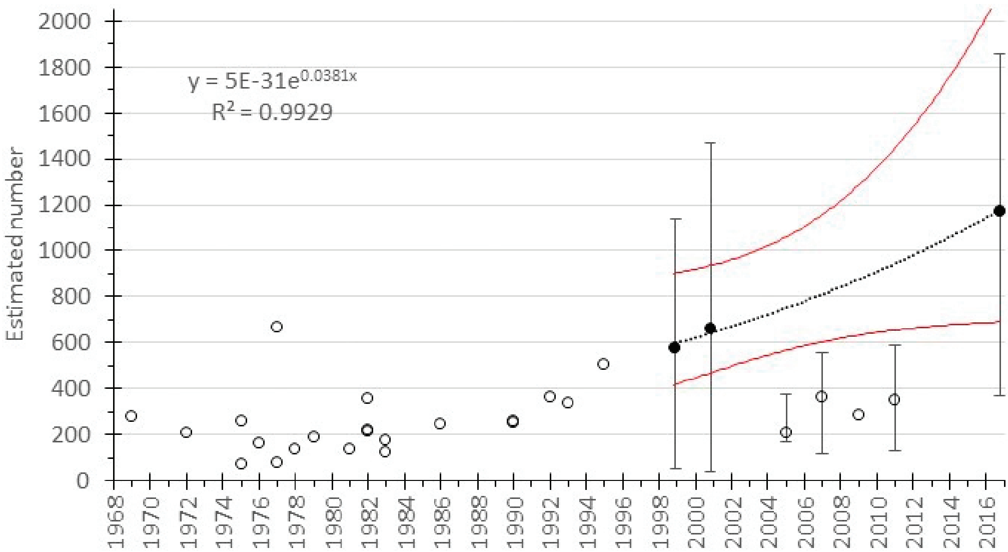

Figure 6. Elephant population trend for north-west Namibia (red lines show the 95% confidence limits on the trend line).

years and surveys have seldom covered the same parts of the elephant range (Gibson 2001) and as a result, only a few are strictly comparable.

Correctly conducted total counts of north-west Namibia (i.e. with a search rate of less than 1.5 km^2 per minute) would require around 2,000 flying hours. Sample counts are therefore the best option—and because transect counts are unsuitable (as it is impossible to maintain a fixed height above ground level in the mountainous terrain), block counts (Craig 2012; CITES 2020) are used for much of the area.

As the number of elephants in this population is of the order of 1,000 in an area exceeding 50,000 km^2, sample counts result in extremely low precision. Greater sampling effort might improve this, but, for example, the 2016 survey took around 140 flying hours—more than is normally expended on the whole of the north-east, and which has 20 times the elephant population. Improving the north-west estimates to a similar level of precision as the north-eastern estimates would require five times the effort employed in 2016 and considerably more resources. Since the population contributes little to the national total, the poor precision of estimates for the north-west is of little importance nationally, although a very important issue at the local level.

Until 1995, reconnaissance flights attempting to conduct total counts seem to have been reasonably effective due to good local knowledge (the estimates are not far below subsequent sample counts).

Surveys that took place between 2005 and 2011 were inadequate for a number of reasons. The sample counts with adequate coverage and search effort conducted in 1998, 2000 and 2016 suggest a greater number, but with very low precision.

The intention with the 2011 and 2016 surveys was to obtain a good sample count in the overall range while maximising the number seen by total counting areas, especially along rivers, in order to produce an estimate which might be imprecise but backed by a good minimum number seen. The 2011 survey counted 133 as a minimum number but the sampling intensity was inadequate in one of the sample strata. The 2016 survey gave 373 as a minimum count with an overall estimate of 1,700 but adjusted down to 1,100 as a result of one outlying value.

Although the 2016 number has increased since the previous comparable surveys in 1998 and 2000, there are insufficient surveys to demonstrate change or to obtain an estimate of it. The estimated rate of change for the north-west population is 3.86% per annum (between -0.08% and 7.95%). However, this is not statistically significant ($F=154.63$, $p = 0.0511$ n.s.).

Etosha National Park

The trend analysis used estimated numbers of elephants from 1998 onward. The estimate for 1995 was omitted from the trend. It was clearly an outlier because the deviation of that year's result from the trend line was close to two standard deviations (derived from the residual variance about the line). Removing that point markedly improved the fit of the other points. In 2011, the estimate for one of the strata was based on a single sighting of 30 animals which resulted in an extremely wide confidence interval. For the trend analysis, the overall estimate therefore excluded the estimate (899 ± 2,365) for this stratum and simply added the number seen to the total estimate.

Early surveys of Etosha National Park have produced extremely variable counts of elephants which are not strictly comparable (Table 6 and Fig. 7).

Numbers increased by a factor of about eight between 1970 and 1980. This is too high to have resulted from natural increase although immigration is a possibility. Most likely, however, is a change in survey methods or quality over that period. Since 1998, surveys have shown that the elephant population has been increasing slowly. The estimated rate of population increase p.a. for Etosha National Park's elephant population is 1.75% (between 0.65% and 2.87%). The trend is statistically highly significant ($F=16.71$, $p = 0.0095$**).

Zambezi Region

The largest of Namibia's elephant populations is found in Zambezi Region where between 9,400 and 14,600 animals were estimated in the 2019 dry season. The population is not closed and there is considerable movement between Namibia and Botswana and to a lesser extent with Angola and Zambia.

Numbers within Zambezi Region may be subject to some fluctuations on account of cross-border movement. The estimate for 2013 was unusually low probably because the survey was conducted earlier in the year (May/June) when the vegetation was still dense and the flooding in the Zambezi catchment was extensive. Nevertheless, there has been a consistent and significant increase in the population at an estimated and biologically realistic annual rate of 4.76% (between 2.73% and 6.84%). This trend is statistically very highly significant ($F=29.88$, $p = 0.0006$***).

The wave of illegal hunting which has afflicted elephant populations in many parts of Africa has not spared Namibia. Of all the areas inhabited by elephants in Namibia, Zambezi Region has been most affected (Craig and Gibson 2013, 2014, 2019; Gibson and Craig 2015) as suggested by increasing carcass ratios (Table 8) (Douglas-Hamilton and Hillman 1981; Douglas-Hamilton and Burrill 1991). Reduction of the population in Zambezi Region may have occurred recently as a result, but the population estimates for

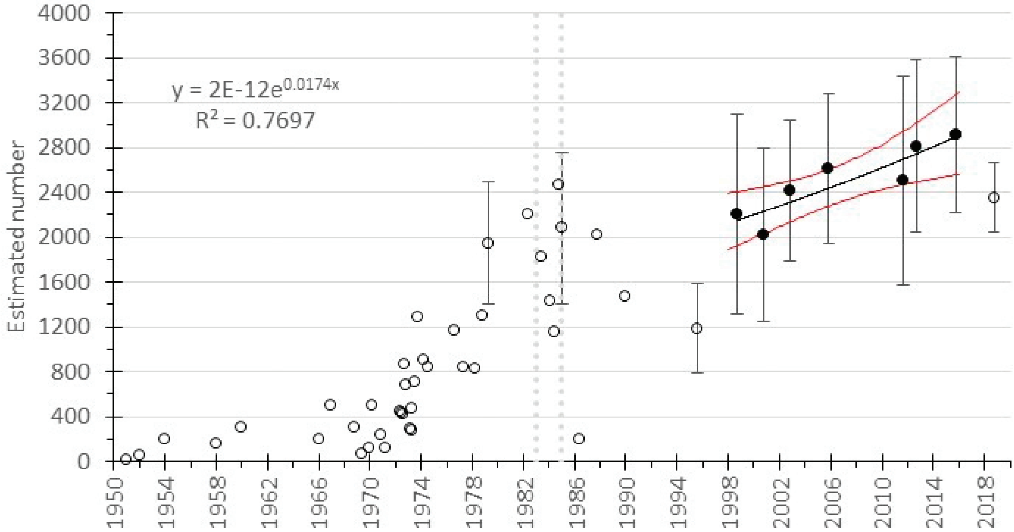

Figure 7. Elephant population trend for Etosha National Park (red lines show the 95% confidence limits on the trend line). Culls are indicated by vertical dotted lines: 220 in 1983, 350 in 1985.

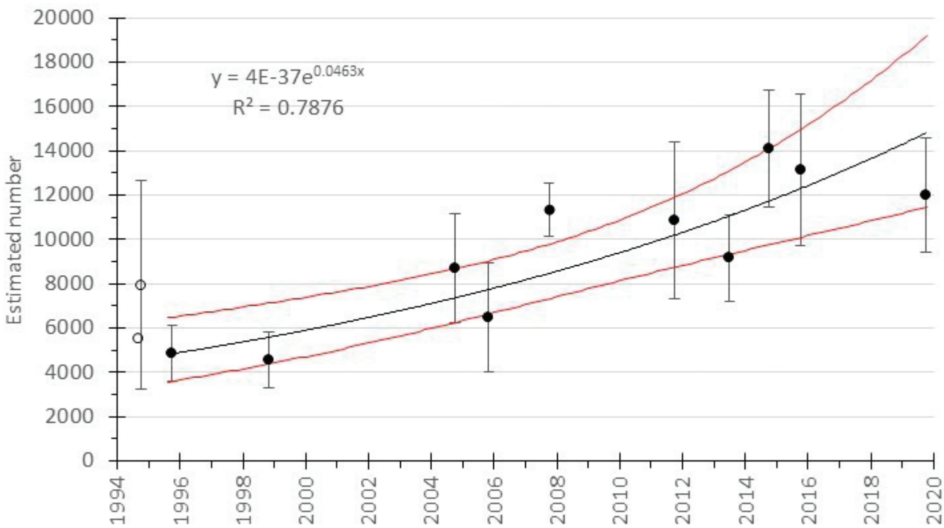

Figure 8. Elephant population trend for Zambezi Region (red lines show the 95% confidence limits on the trend line).

the region are currently within the confidence interval of the long-term growth curve. The last three points on the graph in Figure 8 show a consistent decline, which is not statistically significant but a real effect cannot be ruled out (Craig and Gibson 2019).

There is also a possibility, because of the connectedness of the populations, of the Zambezi Region population being impacted by illegal hunting in neighbouring states. That this was occurring, and continues, in adjacent areas of Botswana was recorded on the 2014, 2015 and 2019 Zambezi surveys (Craig and Gibson 2019) and surveys in Botswana (Chase et al. 2018). There are no later estimates of carcass ratios but there is evidence to suggest that after 2015, elephant poaching had been decreasing (MEFT 2020; Craig and Gibson 2019).

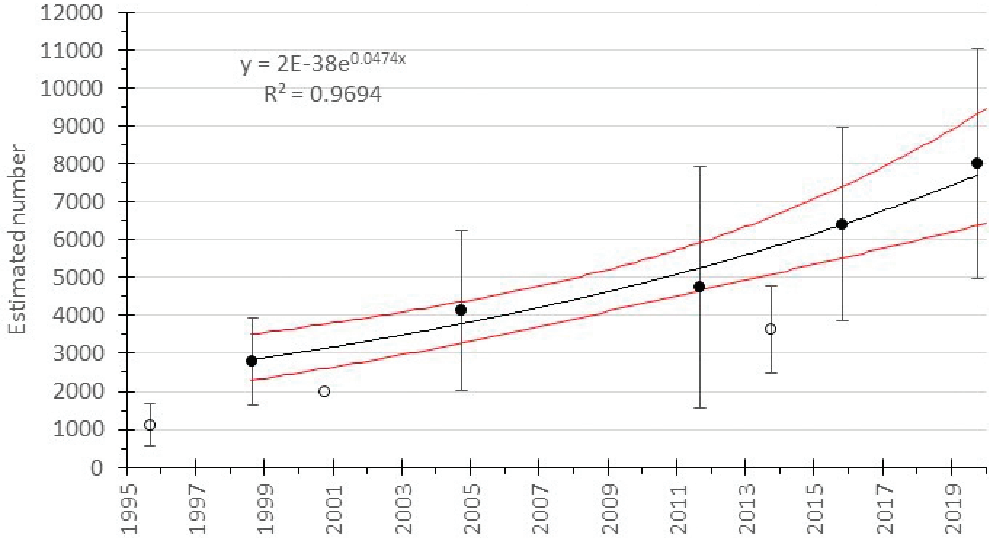

Figure 9. Elephant population trend for Khaudum National Park/Nyae Nyae Conservancy (red lines show the 95% confidence limits on the trend line).

Khaudum National Park/Nyae Nyae Conservancy

Khaudum National Park and Nyae Nyae Conservancy have been combined for the purposes of estimating numbers of elephants as there is no barrier to movements between the two.

Three estimates were omitted from the trend analysis:

- The 1995 survey employed a non-standard approach to sampling.
- The 2000 report was incompletely reported.
- The estimate for 2013 is an outlier. There was an elephant capture operation in the area at the same time as the aerial survey which disturbed the animals and may have caused them to move away leading to a low estimate.

The population has increased at a very highly significant rate (F=95.16, p= 0.0023***) of 4.85% (between 3.24% and 6.48%).

Cross-border movement with Botswana is small compared with Zambezi Region. Links to Zambezi Region are limited and have not been detected by telemetry of Namibian elephants. Numbers are therefore unlikely to be greatly affected by population movements.

There has been little poaching of elephants in the area up to 2019.

Discussion

Since 1990, when comparable surveys began, there is strong evidence of increase, at a rate of between 4.20% and 6.53% per annum, in the total number of elephants in Namibia. A supporting indicator of this is the increasing numbers of incidents of elephants being found well outside the recognized range. With the increase in numbers there has also been an increase in human elephant conflict (HEC) (irdnc.org.na 2021; Jones 2006).

The continental spike in illegal hunting that started in 2007 and is said to have peaked around 2011 (Chase et al. 2016, CITES Secretariat 2013) has been a setback to that growth in Zambezi Region. This has been the only area of concern, but the impact does not appear to have been severe up to end of 2019.

It is important to place the conservation success represented by Namibia's increasing elephant population in a wider historical perspective. That the history of population growth extends further back than the 1990–2019 time-window we have concentrated on here is suggested by the generally upward trend of earlier survey estimates (see Figures 6 and 7) where these are available. The record becomes less reliable the further back one goes, however. This is particularly true for the north-east, the area where most of Namibia's elephants are. Clues to the past come from Botswana.

Satellite telemetry enables a measure of relative time spent in neighbouring countries by animals collared within Namibia. In particular there are cross-border movements associated with the Zambezi Region population. With the collared animals spending about 40% of the time outside Namibia (see earlier Figure 4). It is clear that this population is one shared with neighbouring states, particularly Botswana, and it is therefore likely that the elephants of Namibia's north-east and of northern Botswana have a shared history.

In Botswana elephants were believed to be numerous and widespread until 1800, when the climate was wetter than now (Campbell 1990). By the time the country began to dry up, around 1870, uncontrolled commercial hunting for ivory had reduced elephants to a small remnant population in the north (Campbell 1990). Once controls were put in place in 1893, elephants began to recover and surveys between 1973 and 1975 showed that there were over 10,000 (Campbell 1990).

Available historical accounts suggest that a similar major decline in elephant range and numbers in Namibia took place. By the middle of the century, numbers began to increase in Etosha and after independence in 1990, elephants began to recover also in the north-west. Although there is little historical information on elephants in north-eastern Namibia, reports of increasing HEC after 1962 (Spinage 1990) suggest recovery of numbers there may have mirrored that in Botswana.

The account given here shows the increase of elephant populations within Namibia from the mid 1990s until the present. Evidence from other sources suggests that this may just be the latest stage of a longer-term recovery from low numbers that began in the mid-20th century.

Acknowledgements

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M. Lindeque stimulated a review of elephant distributions and trends under the development of the elephant management plan (MEFT 2020). P. Lindeque provided this information as well as many of the references to early surveys.

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Table 1. Namibian elephant populations, approximate numbers and densities*

Population	Number	Area km²	Density no/km²
1 North-west	1,200	50,000	0.024
2 Etosha National Park	2,900	19,000	0.153
3 Mangetti area	90	4,000	0.025
4 Northern Kavango	50	1,500	0.033
5 Khaudum National Park/Nyae Nyae Conservancy	8,000	13,000	0.615
6 Zambezi Region	12,000	10,000	1.200

*Note that populations 3 and 4 have not been surveyed systematically. The numbers given are guesses and are not dealt with further in this paper.

Table 2. Satellite collars

Range	Number of daily locations	Number of collars	Period
North-west	22,000	42	Oct 2002–May 2013
Etosha	16,000	22	Sep 2009–Oct 2014
Kavango	730	3	Jan 2017–Apr 2020
Khaudum/Nyae Nyae	22,000	30	Sep 2012–Nov 2019
Zambezi Region	21,000	64	Oct 2010–Jan 2020

Table 3. Seasonal areas of range and wet season range expansion from telemetry

Population	Seasonal range component (km²)			Overall seasonal area		Seasonal increase (%)
	Dry only	Overlap	Wet only	Dry	Wet	
North-west	5,538	13,884	8,801	19,422	22,685	17
Etosha National Park	1,794	5,915	6,084	7,709	11,999	56
Kavango/Mangetti	741	858	832	1,599	1,690	6
Khaudum National Park/Nyae Nyae Conservancy	1,287	7,735	4,563	9,022	12,298	36
Zambezi Region	4,368	10,764	10,764	15,132	21,528	42

Table 4. Estimates of numbers of elephants for countrywide total (cl = confidence limits)

Year	North-west		Etosha National Park		Zambezi Region		Khaudum National Park /Nyae Nyae Conservancy		Country	
	Estimate	95% cl	Estimate	95% cl	Estimate	95% cl	Estimate	95% cl	Estimate	95% cl
1995	508	0	1,188	405	4,883	1,248	1,104	555	7,683	1,425
1998	579	560	2,206	893	4,576	1,248	2,776	1,158	10,137	2,008
2004					8,725	2,251	4,127	2,125	14,548	3,242
2005	210	164	2,611	671	6,474	2,445				
2011	351	240	2,509	930	10,847	3,619	4,731	1,955	18,438	4,224
2015			2,911	697	13,136	3,435	6,413	2,566	2,3633	4,397
2016	1,173	681								

Table 5. Numbers of elephants in north-west Namibia

Year	Estimate	95% cl	Survey method	Author/s
1969	279		not stated	Joubert. 1972.
1972	211		not stated	Joubert. 1972.
1975	260		not stated	de Villiers PA In: Viljoen. 1987.
1975	70			Kolberg et al. 2009.
1976	162			Viljoen PJ In: Loutit R. 1995.
1977	82			Visage GP. 1977.
1977	667			Viljoen PJ. In: Loutit R. 1995.
1978	135			Kolberg et al. 2009.
1979	192		transect?	Mulder LK. 1979.
1981	138			Kolberg et al. 2009.
1982	214			Loutit R. 1995.
1982	220			Kolberg et al. 2009.
1982	357		total count	Viljoen PJ. 1982.
1983	126		random strip	Owen-Smith G. 1983 (a).
1983	178		recon	Owen-Smith G. 1983 (b).
1986	247		total	Britz et al. 1986.
1990	260		?total	Carter LA. 1990.
1990	253		not stated	Loutit R. 1995.
1992	366		recon	Loutit R. and Douglas-Hamilton I. 1992.
1993	340		transects and reconnaissance	Loutit R. 1995.
1995	508		recon	Craig GC. 1996.
1998	579	560	block and transect	Craig GC. 1999.
1998	50		block	Kolberg et al. 2009 no. seen reported.
1999	56		recon	Leggett K. 2000.
2000	663	122	block and transect	MET. 2000.
2005	210	164	transect	Unknown 2005 (?MET).
2005	169		transect	Kolberg et al. 2009 no. seen reported.
2007	365	193	transect	Unknown 2007 (?MET).
2007	117		transect	Kolberg et al. 2009 no. seen reported.
2009	352	243	total	Kolberg et al. 2009.
2011	351	240	block	Craig GC. 2011.
2014			block	Craig GC. and Gibson DStC. 2014.
2016	1,173*	681	block and transect	Craig GC. and Gibson DStC. 2016.

*2016 estimate 1,716 ± 1,299. One outlier removed

Table 6. Numbers of elephants in Etosha National Park

Year	Estimate	95% cl	Method	Author/s
1951	20		not stated	Erb KP. 1995.
1952	60		not stated	Erb KP. 1995.
1954	200		not stated	Erb KP. 1995.
1958	160		not stated	Erb KP. 1995.
1960	300		not stated	Erb KP. 1995.
1966	200		not stated	Erb KP. 1995.
1968	301		Total	Bredes et al. 1970.
1969	64		Total	Bredes et al. 1970.
1969	116		not stated	du Preez JS. 1971.
1970	494		?Total with strips	Bredes et al. 1970.
1970	550		not stated	Bredes et al. 1970.
1970	232		not stated	du Preez JS. 1971.
1971	124		not stated	du Preez JS. 1971.
1972	447		Total and recon	du Preez JS. 1972 (a).
1972	433		not stated	du Preez JS. 1972 (b).
1972	419		recon	du Preez JS. 1972 (c).
1972	863		not stated	Reid R and du Preez JS. 1972 (a).
1972	686		totals from Sep "repeated"	Reid R and du Preez JS. 1972 (b).
1973	292		not stated	du Preez JS. 1973 (a).
1973	477		not stated	du Preez JS. 1973 (b).
1973	281		not stated	du Preez JS. 1973 (c).
1973	715	560	not stated	du Preez JS. 1973 (d).
1973	1,293		transects and recon	Joubert et al. 1973.
1974	904		not stated	du Preez JS. 1974.
1974	835	122	transects and recon	Berry HH. 1974.
1976	1,170	164	transects	Berry HH. 1976.
1977	836		transects	Berry HH. 1977.
1978	824	193	not stated	Berry HH. 1978.
1978	1,298		total and transects	de Villiers P and Kyle R. 1978.
	1,947	243	block and transect	de Villiers P and Kyle R. 1979.
1982	2,202	240	total	Berry H and de Villiers P. 1982.
1983	1,819		total and ground	Berry H and Nott T. 1983.
1983	1,437	681	total	Lindeque M. 1984.
1984	364		total	Berry HH. 1984.
1984	1,158		total	Lindeque M. 1984.
1984	2,464		total	Berry H. 1984.
1984	2,081		total	Lindeque M. 1984.
1986	196		total (partial survey)	Scheepers L. 1986.
1987	2,021		total	Lindeque M and Lindeque PM. 1987.
1990	1,469		not stated	Erb KP. 1995.
1995	1,188.2		transect	Erb KP. 1995.
1998	2,206		transect and block	Craig GC. 1999.
2000	2,018		transect	Erb KP. 2000.
2002	2,417		transect	Kilian JW. 2002.
2005	2,611		transect	MET. 2005.

*2011	2,509		transect	Craig GC. 2011.
2012	2,810		transect	Kolberg H. 2012.
2015	2,911		transect	Kilian JW. 2015.
2018	2,355		not stated	Kilian JW. (pers. comm.) 2020.

*2011 estimate 3,378 ± 1,757. Outlier removed.

Table 7. Numbers of elephants in Zambezi Region

Year	Estimate	95% cl	Survey type	Author/s
1994	7,950	4,695	Sample	ULG. 1994.
1994	5,556		Sample	Rodwell et al. 1994.
1995	4,883	1,248	Sample	Lindeque et al. 1995
1998	4,576	1,249	Sample	MET. 1999.
2004	8,725	2,467	Sample	Kolberg H. 2004.
2005	6,474	2,445	Sample	Chase MJ and Griffin CR. 2006.
2007	3,062	0	Total	Chase M. 2007.
2007	11,339	1,178	Sample + total	Chase MJ. 2008.
2009	3,450		Total	Chase M. 2009.
2011	10,847	3,547	Sample	Craig GC. 2011.
2013	9,165	1,967	Sample	Craig GC and Gibson DStC. 2013.
2014	14,097	2,636	Sample	Craig GC and Gibson DStC. 2014.
2015	13,136	3,428	Sample	Gibson GC and Gibson DStC. 2015.
2019	12,008	2,594	Sample	Craig GC and Gibson DStC. 2019.

Table 8. Carcass ratios in Zambezi Region

Year	% Carcass Ratio
1994	3.93
2011	2.63
2013	7.98
2014	5.12
2015	8.27

Table 9. Numbers of elephants in Khaudum/Nyae Nyae

Year	Estimate	95% cl	Method	Author/s
1995	1,104	555	Transect	Craig GC. 1995.
1998	2,777	1,158	Transect	Craig GC. 1998.
2000	663	808	Transect	Craig GC. 2000.
2004	4,127	2,125	Transect	Kolberg H. 2004.
2011	4,731	3,185	Transect	Craig GC. 2012.
2013	3,638	1,148	Transect	Craig GC. and Gibson DStC. 2013.
2015	6,413	2,566	Transect	Gibson DStC. and Craig GC. 2015.
2019	7,999	3,028	Transect	Craig GC. and Gibson DStC. 2019.