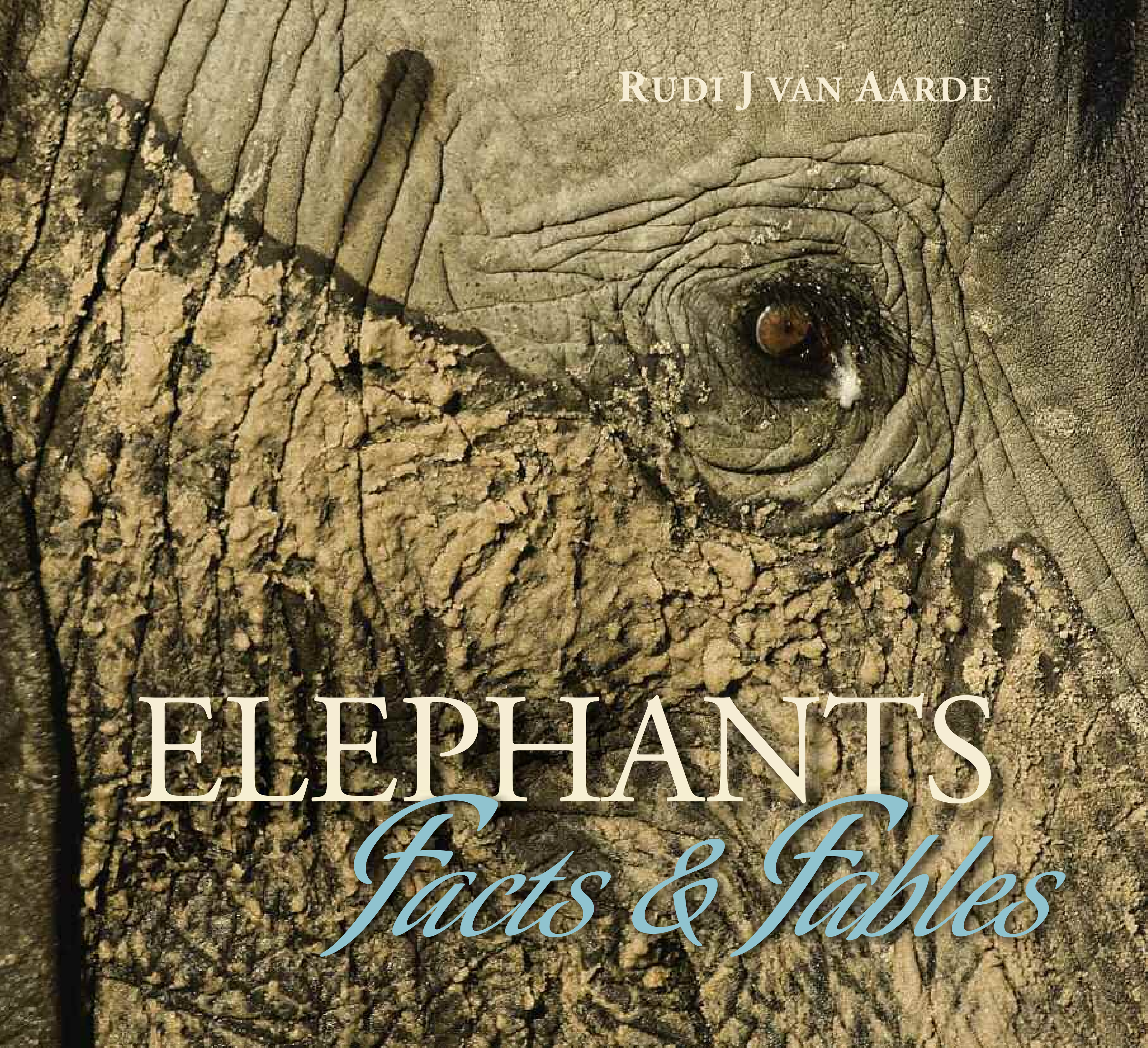

RUDI J VAN AARDE

ELEPHANTS

Facts & Fables

TEXT AND PHOTOGRAPHS
RUDI J VAN AARDE

ELEPHANTS
Facts & Fables

*'Natures great master-peece, an Elephant,
The onely harmlesse great thing; the giant
of beasts'*

JOHN DONNE'S – METEMPSYCOSIS (1633)

Contents

The International Fund for Animal Welfare works to improve the welfare of wild and domestic animals throughout the world by reducing commercial exploitation of animals, protecting wildlife habitats, and assisting animals in distress.

IFAW seeks to motivate the public to prevent cruelty to animals and to promote animal welfare and conservation policies that advance the well-being of both animals and people.

IFAW has partnered with the Conservation Ecology Research Unit (CERU) of the University of Pretoria (UP) on a research programme aimed at understanding the dynamics of elephant populations in southern Africa. IFAW's interest in the conservation management of elephants in the region spans more than 15 years. Through dedicated support for research and practical on-the-ground solutions, IFAW aims to promote ethically and scientifically sound policy solutions to conservation management predicaments involving elephants.

In this publication, IFAW has teamed up with CERU Director, Professor Rudi van Aarde, to shed light on what we really know, and don't, about elephants, their dynamics, and conservation management in southern Africa.

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Foreword

One of the things that has both fascinated and frustrated me for decades is that debates about controversial wildlife issues generally bear little resemblance to the facts as they are known. More often than not, discussions focus on distracting abstractions of reality, and on myths or fables promoted by various participants as they attempt to advance their personal and institutional values, opinions, objectives and agendas. It doesn't matter whether the issue is commercial sealing or whaling, culling or climate change, facts are typically misrepresented or ignored by most participants in the debate.

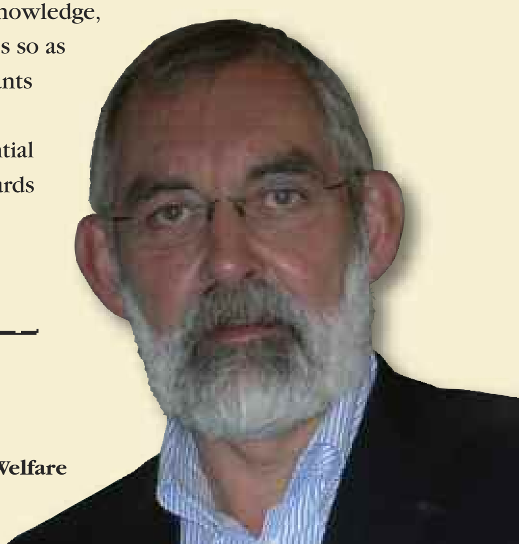
In *Elephants: Facts & Fables*, Professor Rudi van Aarde notes that similar issues plague the debate over elephant conservation. What is refreshing here, however, is that a prominent elephant ecologist has made a constructive attempt to put the discussion on a factual footing.

As is usually the case, the use of science in elephant conservation is highly selective and arbitrary. Much discussion focuses on incomplete and imprecise data on population numbers and trends, ignoring that elephants exist not only as populations, but as unique individuals, and as components of complex ecosystems. Important research – including van Aarde's own work on metapopulations and the significant implications that it has for policy and management decisions – either does not receive the consideration it deserves or is overlooked altogether. Further, relevant information from other sciences, including modern taxonomy and systematics, ethology, animal psychology and neurobiology, as well as from other learned fields, such as history and ethics, is essentially ignored.

One of the most enduring myths in conservation is that humans can 'manage wild populations.' If nothing else, the history has demonstrated that, in fact, we can't. What we can manage – as Sidney Holt first noted decades ago – are human activities, to our own ultimate benefit or harm.

Professor van Aarde correctly notes that the major role that science and scientists can play in conservation is to *inform* discussions of public policy and management. While both will ultimately be based largely on societal norms, and on the values, objectives and – as his own research has recently demonstrated – on the experience of decision makers, the success or failure of conservation actions will most likely depend on the veracity and completeness of the information upon which they are based.

This booklet should encourage people to abandon myths and fables in favour of the facts as they are currently understood and, in the absence of certain knowledge, to apply precautionary measures so as not to further jeopardise elephants in the wild. Not only are such measures critical, they are essential if we are to make progress towards conserving elephants, now and in the future.



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Hearsay often dominates discussion on the 'elephant problem', thus confusing decision making processes and reducing the role of science in conservation management.

Introduction

Personal opinion, hearsay, anecdotes and individual interpretations of research findings all too often dominate heated debates on elephant management. General statements such as 'there are too many elephants', or that 'elephants destroy biodiversity', motivate calls for management. Media reports often boost such calls and often describe the 'elephant problem' in terms of numbers and the rates at which numbers change over time. This, combined with the selective use of words such as 'destroy', 'destruction', 'extreme', and 'overabundance' can imply that the elephant problem resides in numbers and growth rates and that numbers should be managed to reduce the impact of elephants on other species. This assumption is flawed and just one of many examples that can be used to illustrate how a misconception on elephant management is generated through personal interpretations. It therefore is not surprising that fables replace facts when proposing solutions for the 'elephant problem', or when discussing elephant conservation.

In this publication I address some of the less than factual generalisations that dominate discussions on elephant management. Most of the information presented here stems from more than a decade of intensive academic research on elephant populations in southern African countries such as Botswana, Malawi, Mozambique, Namibia, South Africa and Zambia.

Is the African elephant endangered?

The precarious status of Africa's elephants is not really a matter of debate and a cautious approach to its conservation status makes sense. The apparent killing of about half of Africa's elephants in the 1980s motivated the Conference of the Parties (CoP) to the Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES) to list African elephants on Appendix 1 of the Convention in 1989. This banned international trade in ivory. Present opinions on the status of elephants differ across the continent and some conservation officials from several southern African countries level arguments to favour trade in ivory as a reward for their management efforts that led to the increase in elephant numbers. Most East African and a growing number of West and Central African countries feel differently, and officials believe that the resumption of legitimate trade will fuel illegal ivory poaching and threaten dwindling populations elsewhere on the continent. Present estimates suggest that some 470,000 – 600,000 elephants live in Africa, some of which are better protected than others. Recent poaching sprees and the shrinking of natural habitats for elephants in Central and West Africa are of great concern. Some feel that the forest elephant and some savannah elephant populations are in deeper trouble than ever before. Both West and East African populations are losing habitat due to increasing developmental demands. These threats do not seem to be apparent across most of southern Africa where elephants in several countries are extending their ranges, though it may be in response to either good or bad management practises. Based on numbers it may well be argued that the African elephant is not endangered in southern Africa, but that several local populations are severely threatened. Accepting scientific reasoning that motivates the distinction between savannah and forest elephants as distinct species however, may alter this viewpoint, especially due to the threats that forest elephants are now experiencing.

Elephants, like most other mammals, depend on water, not only for drinking, but also for thermoregulatory needs. During the heat of the day they often bath and play when the opportunity arises. The early development of their kidneys and lungs suggests that elephants may once have been well adapted to living in water.

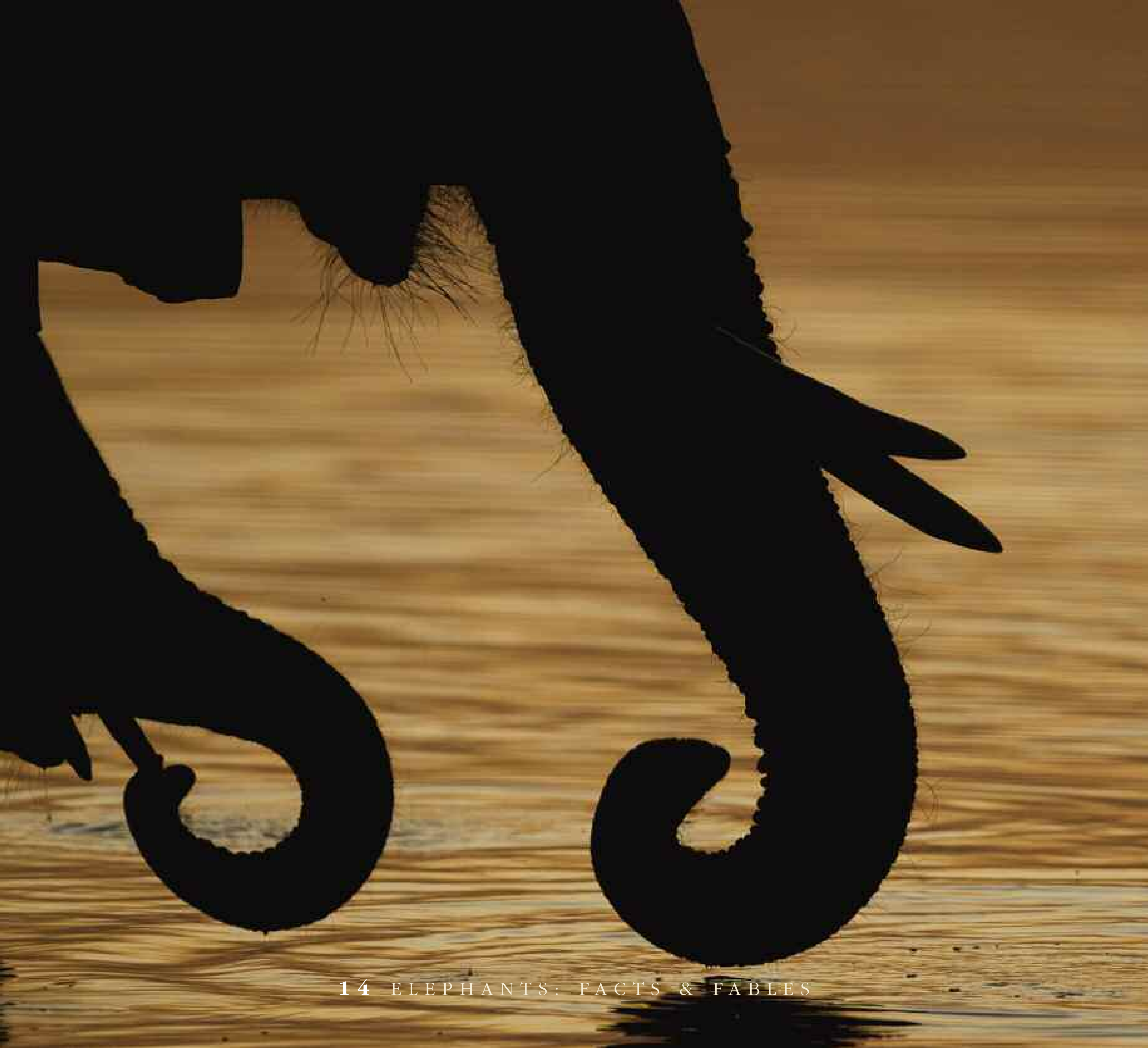
Ivory poaching continues to threaten the survival of elephants in some southern African populations

This is true. For instance, several Zambian populations have few large and old elephants, herds are small and individuals are often tuskless. The imbalances in age structures would suggest that most populations in Zambia have not recovered from past intense poaching and may still be exposed to some poaching. Censuses imply a continuing, albeit slow, decline in some populations. This supports an independent genetic assessment that suggests Zambia as one of several focal points of poaching in southern Africa. More recently, parts of northern Mozambique and southern Tanzania, have become the focus of large scale poaching initiatives. Large scale poaching driven by syndicates may be more intense than ever before.

Water is a key resource for elephants

Elephants depend on water. Water is a key resource and the distribution thereof dictates their use of habitat. Consequently, elephants usually roam within relatively close proximity to water and breeding herds seldom wander more than 10 kilometres from water.

Elephants are long-lived and typically experience several droughts during a lifetime, especially when living in savannahs where three to four-year long droughts may recur at about 12 year intervals. They typically lose body condition during the dry season but gain body reserves during the wet season when the nutritional value of their preferred food is relatively high. Their large bodies enable them to withstand nutritional stresses, as do the wide choice of plants they feed on. Death due to starvation does occur, but elephants are capable of moving relatively long distances in search of food, although roaming distances of breeding herds are limited by the abilities of calves.



The destruction of plants around artificial water points, especially in sensitive habitats that are not adapted to cope with intense trampling, grazing and browsing should be blamed on the incorrect placement of the water points, rather than on elephants.

Elephants can cope with extreme environments

This is indeed the case and elephants live in habitats ranging from desert to forests. Behavioural and physiological adaptions keep their body temperatures relatively constant and for this they are dependent on water to drink and cool off during the heat of the day - especially during dry, hot times of the year. During hot summers they apparently offload heat by seeking relatively cool areas at night. Conversely during cold winter nights elephants will actively seek warmer areas under tree cover. Elephants also feed on a great variety of trees and grasses and often their preferences are dictated by availability rather than choice. In a few cases their preferences for certain rare plants may induce local extinctions. In many cases such extinctions do not occur, and plants may escape destruction because they grow in places inaccessible to elephants, such as on steep mountain slopes or in hilly terrains.

Do elephants have a negative effect on other species?

Elephants destroy individual plants by uprooting trees and/or breaking their branches. They also remove bark from trees, thereby making trees susceptible to insect infestation and fire. More trees close to water are destroyed by elephants than trees further away from water. Fallen trees are known to enhance the presence of certain lizard species while the lack of trees is speculated to influence birds that nest in holes. We have no proof of tree damage affecting bird distribution as has been speculated by some proponents of culling. A study in Zimbabwe showed that reduced tree cover induced a reduction in the number of ant and bird species in Miombo woodlands. The destruction of trees also goes hand in hand with elephants being confined for extended periods to relatively small areas, or to their food being limited by management practises such as the removal of shrubs and bushes to enhance wildlife sightings. Recent work also suggests that the pushing over of trees is more prevalent after fire and frost, probably due to food being in short supply.

Does the African savannah need elephants?

Yes, for we know that African savannahs are structured by climatic and biological interactions. The so-called arid and transitional savannahs that receive less than 600mm of rainfall per year persist as a mixture of grasses and trees through droughts, while the wet savannahs, which on average receive more than 800mm of rainfall per year, persist in response to the disturbance invoked by herbivores that feed on grasses and trees. Elephants often dominate the herbivore guild in savannahs and consequently play a major role in modifying the structure and function of these landscapes. Their feeding on trees alters canopy shape as well as the survival of saplings and adult trees, thereby ensuring micro-scale environmental conditions that allow grasses and trees to co-exist. These changes and the absence of elephants may favour bush encroachment. This may disadvantage herbivores that feed on sun-loving grasses and sedges. The elephant is thus an important component of savannahs.

Elephants are ecological engineers that maintain savannahs

Elephants do have the ability to shape the structure and function of the systems of which they are a part. They have been allocated statuses such as 'keystone species', 'umbrella species' and 'ecological engineers', some of these as a matter of speech rather than by the roles that elephants fulfil in their natural environs.

Can science dictate the conservation management of elephants?

This is a fable – science and scientists can only contribute to management as a process that is dictated by societal norms as expressed through value systems. Science does, however, provide a foundation and sets of tools that should be used in framing, developing and evaluating conservation management decisions/approaches. Debates on elephant management are often ruled by personal opinion while most scientists support the scientific method and approach as tools to guide and develop ecologically meaningful and site specific conservation management protocols for elephants. In this regard the South African government excelled by calling on reputable scientists to assess the management of elephants as part of a round table discussion. Their findings and interpretation gave rise to a book entitled *Elephant Management: A Scientific Assessment for South Africa*, edited by RJ Scholes and KG Mennell (Wits University Press, 2008). The assessment has reduced some of the uncertainty associated with management exposing the important gaps in our understanding.

Elephants have had the misfortune of being referred to by some as a 'problem species' and even a 'pest' while others have coined phrases such as 'flagship species' and 'conservation ambassadors'. None of these have a scientific meaning.

Was past management of elephants based on scientific research?

Not always – some scientists, but not science may have informed management, mostly based on counts of elephants that often did not meet scientific standards. Personal interpretations of these counts often motivate management decisions, sometimes based on experiences that suggest that 'one elephant per square mile' should be the norm for management. This suggestion has no scientific foundation and elephant densities vary greatly across southern Africa.

The limited role of science in past management decisions is no different for elephants than for many other species – managers often give more weight to experience than to formal scientific research findings. One of the reasons for this is the inaccessibility of research findings, be it that research does not address specific management issues, or scientists presenting their findings through channels and/or terminologies that are inaccessible to managers. Our recent questionnaire survey on management decisions in South Africa showed that at least two-thirds of present managers base their management objectives and decisions on experience rather than on science.

Is an increase in elephant numbers a measure of conservation success?

No, not always. Conservation measures such as the control of poaching certainly provided for safe havens where elephants could reside and where numbers could increase in response to conditions that favoured elephants. The fencing of conservation areas and the provision of water through waterholes often provided these favourable conditions. Fencing and water provision, however, created a new set of problems. Fences hinder dispersal movements and water provisioning reduces natural die-offs during droughts. A lack of opportunities to disperse and high survival rates drive high rates of increases in numbers. In conservation areas management actions such as these thus may have caused the so-called 'elephant-problem'.

Elephants destroy trees

Elephants certainly do kill trees by uprooting, debarking and/or breaking branches (thereby making them more susceptible to fire and/or infestation by wood-boring insects). Savannah trees, however, are also killed by fire and droughts and often it is difficult to distinguish the causes of tree mortalities.

Scientists working in South Africa's Kruger National Park and in Botswana's Chobe National Park noted (in independent publications) the consequences the rinderpest (infectious viral disease affecting both cattle and other large herbivores, which reached epidemic proportions in southern Africa in the 1890s) epidemic may have had on tree survival – their notion is that the dramatic fall in herbivore numbers through this exotic disease provided trees the opportunity to establish and to survive to adulthood in abnormally high numbers. This skewed tree numbers in the savannahs. The recent recovery of some elephant populations may therefore reduce tree numbers to their more natural state.

Do high elephant numbers explain their impact on vegetation?

No, it does not – elephant numbers per unit area vary greatly in conservation areas across southern Africa – some places that experience high impact do have lower elephant densities (number of individuals per unit area) than some places that experience little impact. It is more likely that impact is due to fences and the provision of water obstructing and altering seasonal and between-year movements of elephants. Such interferences often force elephants to make use of the same areas throughout the year and from year to year, thereby not giving plants the seasonal and periodic relief that enables their natural recovery. Under such conditions, impact is the outcome of spatial limitations, rather than numbers. The management of the so-called 'elephant problem' therefore should focus on the impact of human decisions (e.g. fences, waterpoints, etc.) and not elephant numbers.

Free-ranging elephants have distinct summer and winter ranges. During the rainy season they roam widely and mainly live off nutritious grasses. During the dry winter months they may continue to feed on grasses but then supplement their diet with sedges, forbs and the leaves, twigs and even branches of a variety of bushes and trees. Their uprooting and debarking of trees mainly occurs towards the end of the dry season when food is scarce.

High birth rates allow elephants to increase rapidly

This is not true. Under ideal conditions the average female elephant gives birth when 12 years old and produces 12 calves over an ideal lifetime of 60 years. Considering that half of these calves will be females, each of whom, if exposed to conditions similar to those that their mothers experience or have experienced, will produce the same number of calves. Under these theoretical conditions the population could increase at about six per cent per year through births and deaths. These conditions never prevail in nature and not all calves survive to reproduce. Consequently, some populations may increase at three to five per cent per year, but most populations increase at lesser rates, some stabilise in numbers and some decrease, albeit in response to poaching, habitat loss or dispersal movements out of their range.

The birth and death rates of elephants change with numbers

This is partly true, as increasing numbers give rise to increased densities, which can reduce birth rates but not always increase death rates. In wet savannahs conception rates vary with rainfall and primary plant productivity. In dry savannahs death rates apparently increase with increasing variability in rainfall due to extended droughts. More recent research furthermore suggests that survival during the first year of life drives population growth in dry savannahs. However, in wet savannahs variation in birth rates drives population growth. Rapid changes in elephant numbers, however, are more likely driven by dispersal movements where such opportunities exist.

Rainfall related food production can alter both the breeding rates and survival of elephants. Predicted changes in rainfall due to climate change may therefore have major impacts on elephant numbers across the continent, as is already the case in drought stricken parts of East and northern Africa.

Are there too many elephants?

This is a matter of personal opinion. Africa currently has only about half the elephants it had some 40 years ago – between 1970 and 1989 illegal poaching apparently reduced elephant numbers to around 500,000. Zambia's Luangwa valley presently has only about a quarter of the elephants that lived there in the early 1980s. At about 130,000 elephants, Botswana's population is also about a third lower than in the early 1900s. That said, it should also be noted that elephants are notoriously difficult to count. Consequently, scientists rely on sampling procedures that yield estimates of population size as indices of real numbers. These indices are mere mathematical abstractions based on surveys of which the precision varies with numbers and with survey intensities. Due to costs, surveys seldom cover more than 10 per cent of the area of land where elephants occur in protected areas. Inaccuracies due to thick vegetation cover that limits elephant sightings, the characteristics of the survey areas, observer bias and experience or lack thereof, as well as the number of elephants that live in an area all contribute to levels of precision. In general, precision is extremely poor with an average value of 65 per cent for the 596 estimates that we have assessed. This means that a population estimated to comprise 1,000 elephants may have as few as about 660 or as many as about 1,350 elephants. Most estimates are therefore by no means a true reflection of the actual numbers of elephants that live in a specific area. The statement that there are too many elephants therefore has a poor foundation and little scientific support.

Is it true that elephant numbers are increasing rapidly in most protected areas in Africa?

No, it is not true. Our research shows that nearly half of the estimates of elephant numbers from across Africa are of low quality due to extreme extrapolations, field conditions, low survey intensities and high aircraft speed during surveys. Consequently most of these estimates are inadequate for the detection of growth rates in a scientifically acceptable manner.

Two-thirds of 156 elephant populations in Africa for which relatively good census data exists may be stable, but only one- third of the time series on which we based this assessment had sufficient statistical power to deduce that populations were stable. Some elephant populations in Africa are increasing, some are decreasing, and several are stable. Due to a lack of good information no definite conclusions can be reached for most free-ranging elephant populations. With singular exception, the abnormally high rates of increase (7 – 25 per cent per year) in many of South Africa's newly founded elephant populations, mostly on privately owned land, are due to synchronised calving and skewed age composition of these small populations. In southern Africa most large elephant populations for which we have reasonably precise and accurate data are growing at rates ranging from zero to 4.5 per cent per year.




WITHOUT MANAGEMENT ELEPHANT NUMBERS WILL DOUBLE IN 10 YEARS

This statement is false and based on unrealistic assumptions and inflated estimates of population growth. Under the most ideal conditions elephant populations that increase through births and deaths may double in about 13 years as an outcome of a maximum intrinsic rate of increase of 5.5 per cent per year, only under the unlikely assumption that environmental conditions will be constant over the period of increase. Higher growth rates can only be achieved through skewed immigration, often in response to water provision, or may occur in newly founded populations that through chance events experience synchronous births soon after having been established, or in breeding herds with an unstable age structure, as has been noted in several newly founded populations in South Africa. The calculation of doubling time is based on the unlikely assumption that resources cannot limit population increase. Recent work shows that reproductive rates decline with density (numbers per unit area) while death rates increase with increased variability in rainfall. All of this will reduce population growth rates and increase the doubling time of populations.

CULLING REDUCES NUMBERS BUT NOT IMPACT

This is true. If implemented continuously and at a rate higher than that at which a population grows, the culling of elephants in confined populations will reduce their numbers. On the other hand from our assessment of elephants in Kruger National Park it follows that culling also stimulates surviving elephants to immigrate into areas where numbers have been reduced through culling, possibly because the competition for resources in such areas may be minimal. Moreover, by lowering elephant numbers we relieve vital rates from limitations enforced by high numbers. Culling then may effectively enhance population growth. All elephant populations exposed to culling increased in numbers after the cessation of culling, sometimes at higher rates than what can be explained by births alone, thus supporting the notion that culling stimulates immigration and enhances population growth. Furthermore, we have no evidence that culling reduces the impact of elephants on vegetation. For instance, in the Kruger National Park, where some 17,000 elephants were culled over a period of 27 years, tree numbers declined by some 38 per cent for most of the time when culling kept population numbers stable. This provides further support for the notion that impact should be managed by managing spatial utilisation patterns rather than numbers *per se*.

CONTRACEPTION CAN LIMIT THE 'ELEPHANT PROBLEM'

Contraceptives can be applied to elephants and can limit individual reproductive output. Contraception can even reduce population growth rates from five per cent to zero per cent when applied to at least 75 per cent of all breeding females in a population that are continually treated for some 11 to 12 years. Contraception, however, does not reduce elephant numbers instantaneously, nor does it stop elephants from feeding on trees – contraception thus does not address the impact that elephants may have on vegetation and other species. Contraception may be used to control the sizes of breeding herds in small and intensely managed areas. The long-term consequences of contraception for the social well-being of individuals are not known.

ELEPHANT POPULATIONS CAN LIMIT THEIR OWN GROWTH RATES

This is not true. Growth rates are limited by resources (water and food) and regulated by changes in birth and death rates. Theoretically, populations tend towards a state where numbers remain relatively stable over time – consequently their long-term growth rates centre on zero, either in response to intrinsic (density related) mechanisms or extrinsic (environment related) factors, or both. The suggestion that elephants are limited by growth rates holds true only where management, such as the provision of water and the placement of fences, are not interfering with processes that limit growth rates. New research also supports earlier notions that both the calving interval and the age at which a heifer will calve for the first time increases with an increase in elephant densities. The survival of these calves and of other elephants seems to decrease with increased variability in rainfall. Reduced survival and reproductive outputs reduce population growth rates and some of the largest elephant populations in southern Africa (notably that of northern Botswana) have stabilised, probably due to reduced birth rates, although increased dispersal and the extension of their range into neighbouring countries may also explain stabilisation. Increased dispersal movements also accounts for the recent stabilisation of elephant numbers in Zimbabwe's Hwange National Park and more recently for elephants in South Africa's Kruger National Park.

Elephant management should not be based on numbers alone

This is true. Management that focuses on numbers ignores that the impact that elephants may have on other species results from the way that elephants utilise land and the space available to them. The way they utilise space in fenced-off protected areas is dictated by the distribution of water and by fences that hinder roaming behaviour, emigration and immigration. Management should focus on impact and therefore on spatial utilisation and not on elephant numbers *per se*. The importance of space for the natural regulation of elephant numbers and their impact on other species is widely recognised and now incorporated in management plans for several elephant populations across Africa. The restoration of natural movement patterns driven by season and/or by food availability, or by numbers, provides new management opportunities.

Dispersal can limit elephant numbers

This notion is supported by recent research on populations in Botswana and Zimbabwe. Dispersal (immigration and emigration) adjusts population numbers to short-term changes in food and water supplies, thereby decreasing or increasing the growth rates of populations locally. Although there is relatively little data on dispersal in elephants and the effects thereof, there is evidence that the construction of fences around conservation areas may lead to an increase in numbers, because elephants are no longer able to disperse out of these areas. Furthermore, in northern Botswana, while elephant numbers increased over 20 years, their densities remained relatively stable over the same period, probably because of elephants moving to neighbouring countries. The stabilisation of elephant numbers in Zimbabwe's Hwange National Park also has been ascribed to dispersal movements. Here, water provided by management attracts elephants while the lack thereof, due to dysfunctional water holes, repels them. Dispersal movements induced by water management therefore may be important for the management of elephant numbers and the impact that elephants have on vegetation.

Given the opportunity elephants can move relatively rapidly into previously unoccupied areas. Their presence and activities then can alter woodlands and maintain savannahs in dis-equilibrium that enable many species to co-exist. This important role of elephants in the dynamics of African savannahs is poorly understood and is receiving more attention from a new cohort of scientists.

VARIABILITY IN ENVIRONMENTAL CONDITIONS MAY LIMIT ELEPHANT POPULATIONS OVER TIME

This is likely to be the case, as all animals respond to prevailing environmental conditions. Environmental conditions however, change continuously and dictate the availability of food and water, both of which dictate the way that elephants utilise habitat and space over time. Given the opportunity, elephants will select certain habitats over others and usually choose those habitats that provide best for their needs. They will move away from deteriorating habitats or habitats that do not meet their needs. Such movement can reduce numbers locally and provide for the recovery of vegetation. Our recent assessment shows that food availability, rainfall and elephant numbers collectively determine daily roaming distances, which in turn influence the survival of young – the more elephants there are, the longer the daily roaming distances and the lower the survival of calves. From this we infer that variability in environmental conditions may limit elephant numbers over time.

THE 'ELEPHANT PROBLEM' IS ONE OF LIMITED SPACE, NOT NUMBERS

Several peer-reviewed research papers in leading international journals support this notion. Recurrent local colonisation and extinction events drive the dynamics of many animal species that exist as so-called 'metapopulations'. The variability on living conditions across space allows for elephant numbers to vary across space and time. Survival and breeding rates also vary in response to varying environmental conditions. All of this culminates in differences in the birth rates, survival rates and growth rates of different populations. When interconnected a collection of such populations may form a relatively stable metapopulation.

A metapopulation is no more than a collection of populations that may interact through dispersal of individual elephants between populations. The dynamics that drive birth-, death-, emigration- and immigration rates of these populations should differ at any given time. These conditions certainly hold for elephants that range freely.

Elephant populations exist in a metapopulation structure

Metapopulations are collections of populations (sometimes referred to as sub-populations) that exchange individuals and that repeatedly colonise land that has become vacant through local extinctions. To exist as a metapopulation the demography (birth, death, emigration and immigration rates) of sub-populations must differ and be in asynchrony. Individuals, furthermore, must disperse and at a given point in time, the continuity in landscapes must provide for both occupied and vacant habitats. Given these requirements elephants certainly may be defined as having a metapopulation structure when living without the confines imposed by artificial boundaries.

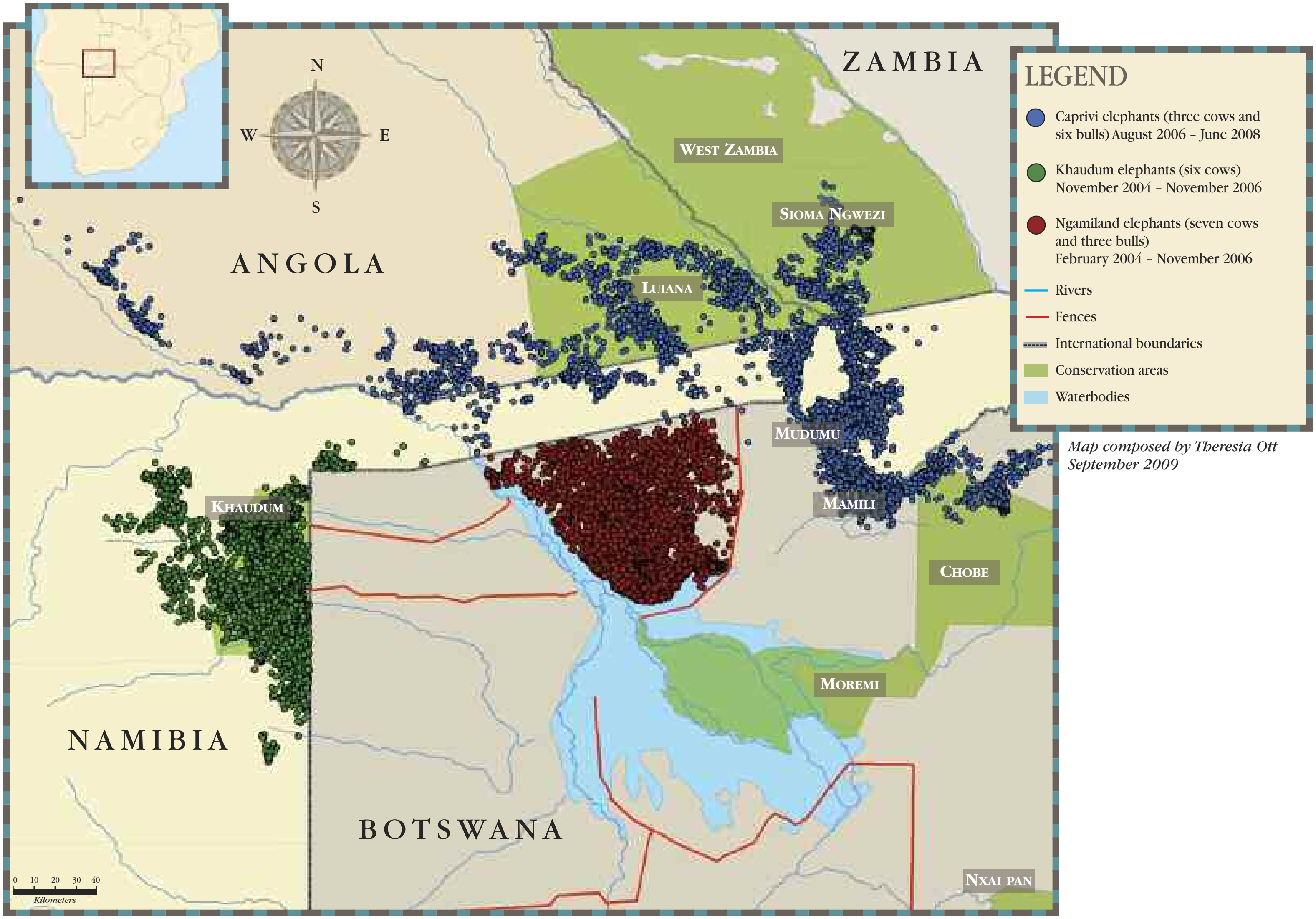
Recent assessments show that the demography of elephants does change across landscapes and that longer-term change in numbers of different populations do differ, with some populations being stable, some decreasing, and some increasing. Elephants are also known to colonise vacant land and the varying mosaic of landscapes across their southern African distributional range allows for repeated colonisation. The likelihood of elephant populations functioning as a metapopulation is thus high and research on the topic continues.

Metapopulation management can address the 'elephant problem'

The metapopulation approach is a component of spatial and habitat management. It focuses management on landscapes rather than populations and on impact rather than numbers. It provides for the manipulation, albeit natural or artificial, of short- and long-term spatial occupation and hence for the impact on vegetation to vary over time and across space. Depending on scale, such variability allows for the co-existence of plants and animals. As the 'elephant problem' in protected areas is one of impact on other species, such management addresses the problem directly, rather than indirectly. Metapopulation management is not an option for elephants kept under highly artificial situations and behind fences on relatively small pieces of land. Management of these semi-captive groups of elephants cannot be based on ecological principles and may best be achieved by applying agricultural concepts that artificially manipulate breeding rates and roaming movements.

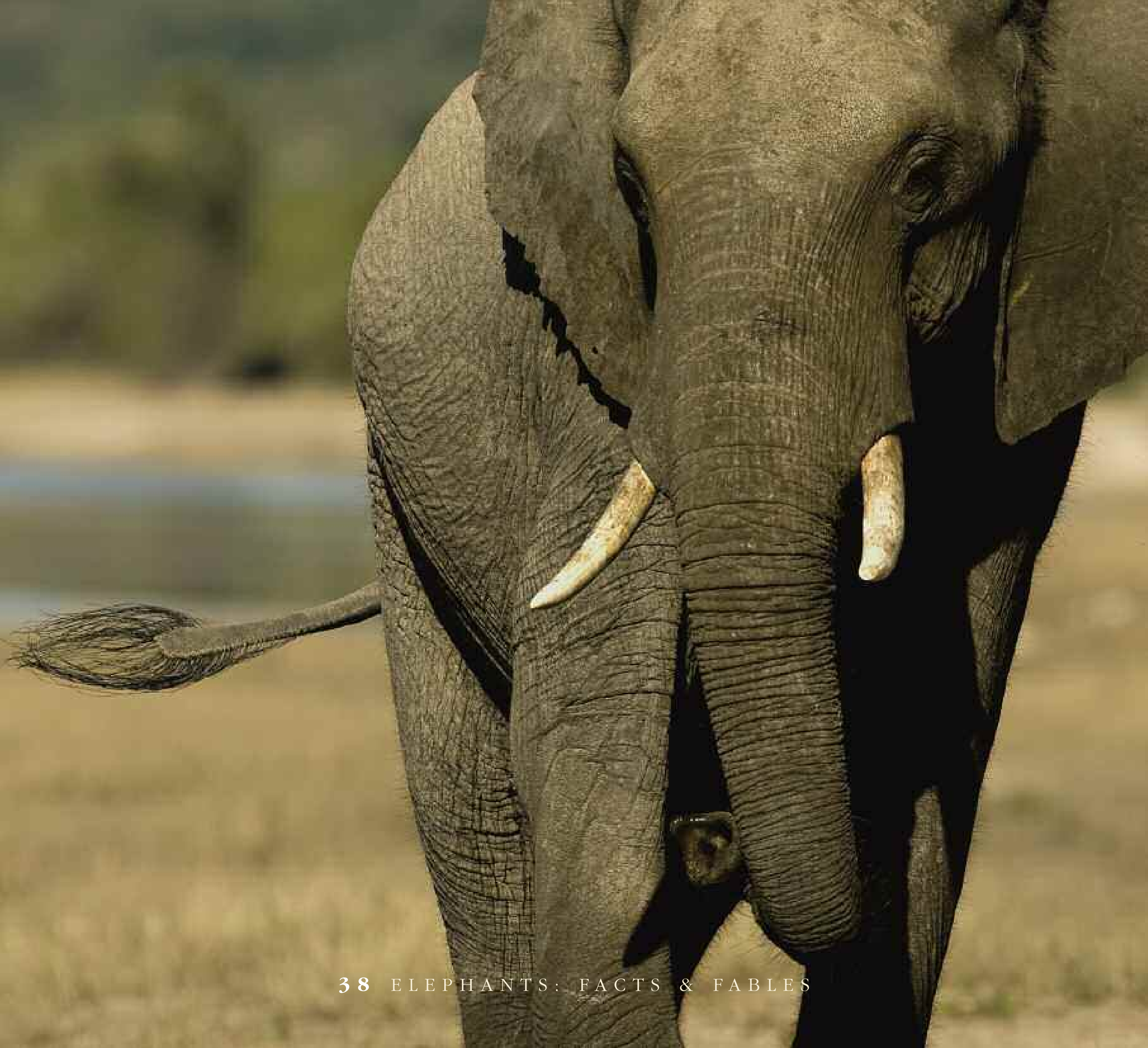
Most of southern Africa's elephants are not restricted by fences and move freely across the land. In spite of this, most elephants live in formally protected areas close to water and away from people. The linking of these protected areas into a network of conservation land will provide for metapopulation dynamics that stabilise population growth and restore habitat utilisation patterns. This will naturalise the impact that elephants have on other species.

ELEPHANT MOVEMENTS IN PART OF THE KAZA TFCA

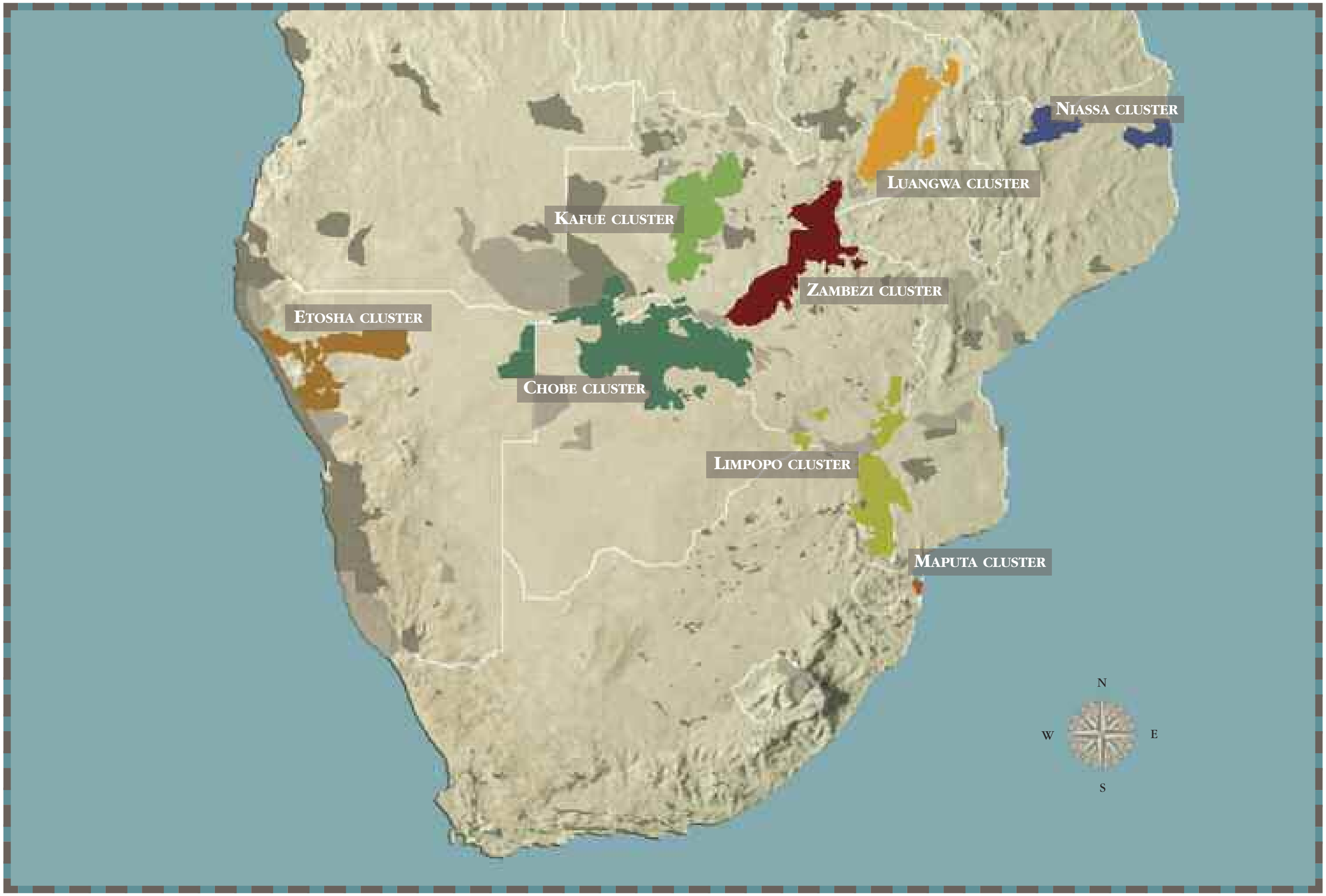


Map composed by Theresia Ott September 2009

Elephants without passports – Several years of satellite tracking shows that elephants roam from one country to another, especially where borders are not fenced. The dots in the diagram show the daily locations of 18 breeding herds of elephants over a period of two years. Fences (indicated in red) limit movements but not borders. From an ecological perspective the conservation management of elephants should be an international rather than national activity.

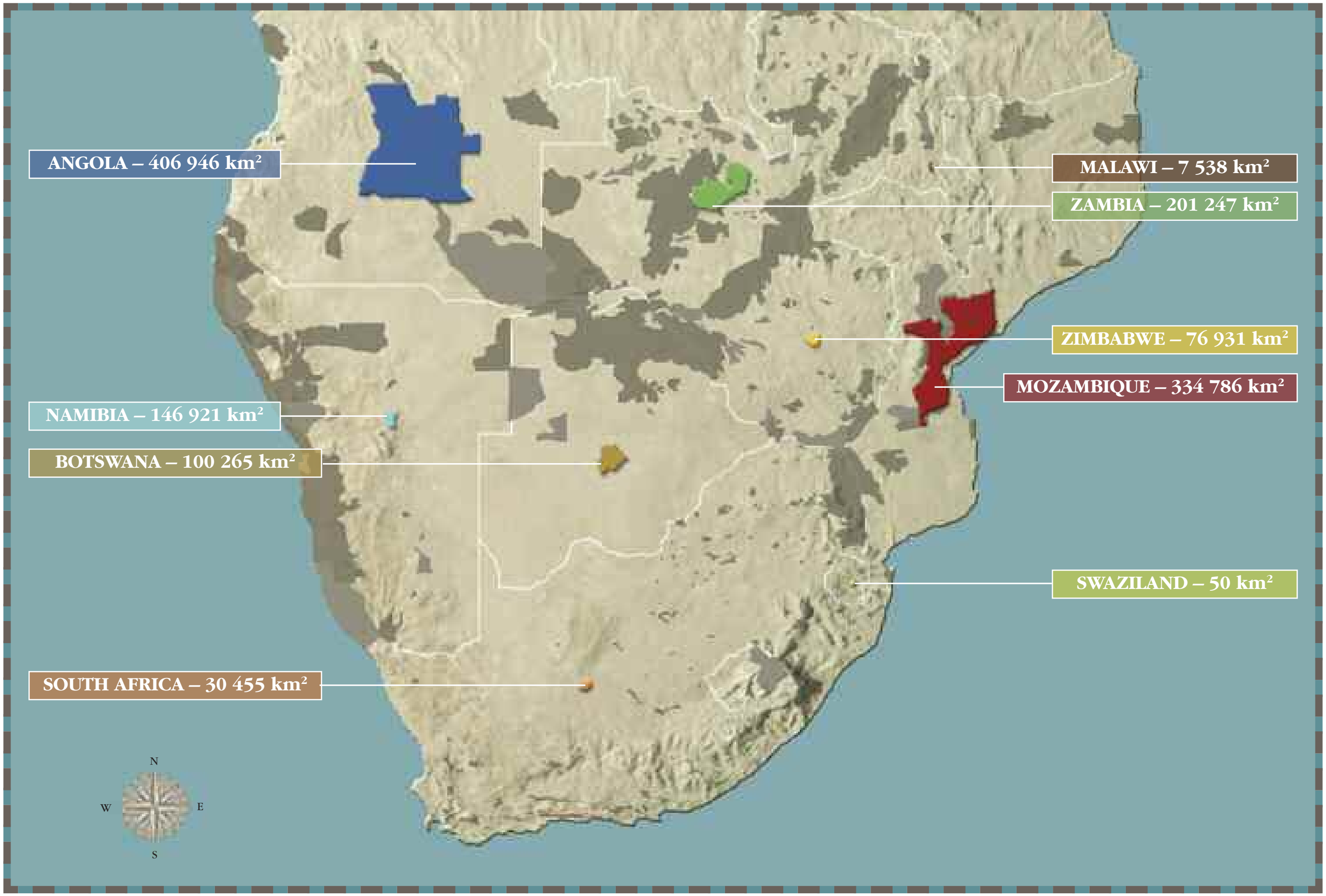


CLUSTERS OF ELEPHANT POPULATIONS ACROSS SOUTHERN AFRICA



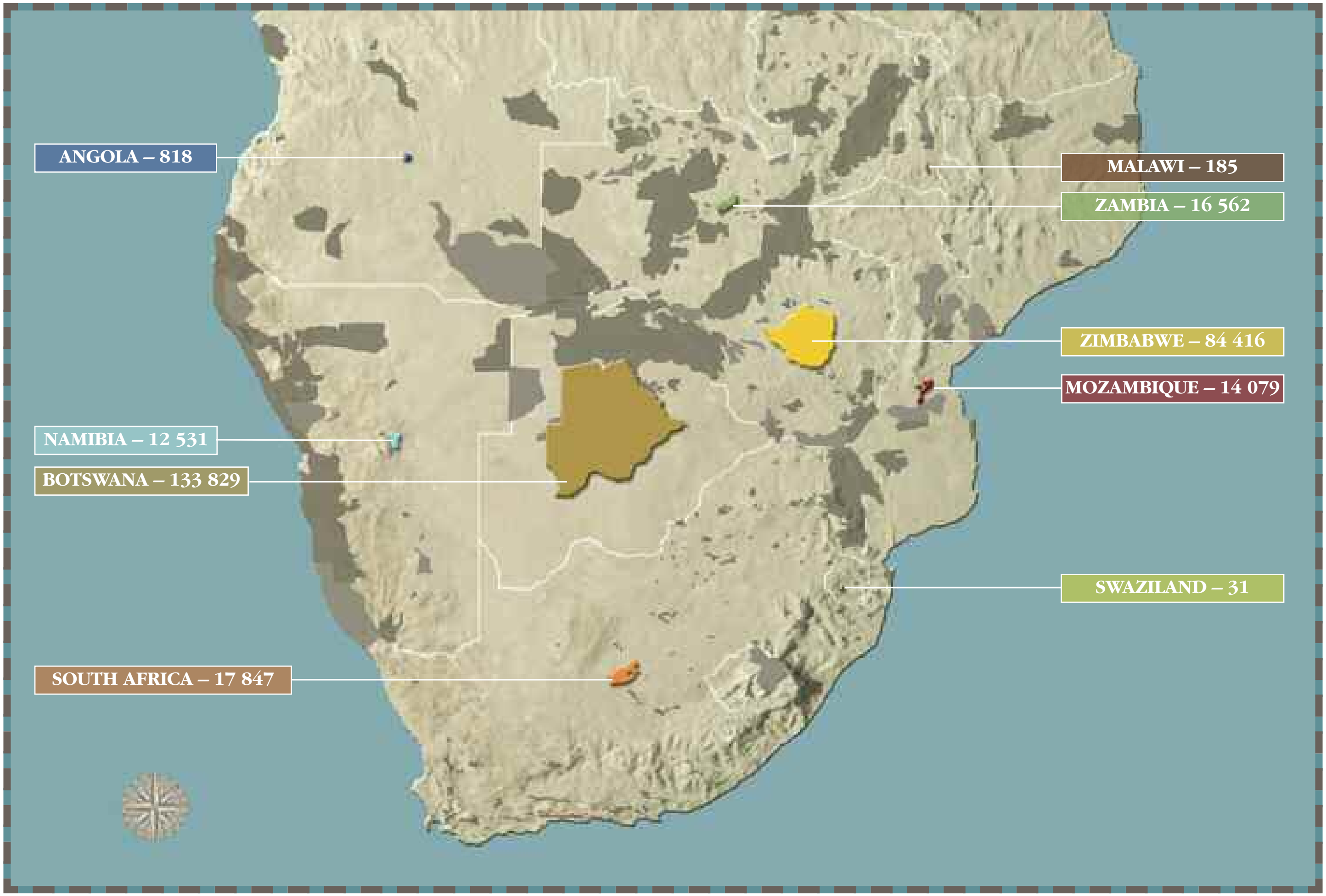
Some 20 per cent of the area (shades of grey on the map) of southern Africa is protected to a lesser or greater extent, all depending on the objectives that have been set by each country. Elephants dominate many of these areas (coloured areas on map) and populations within protected areas shaded in the same colour may function as metapopulations. Each of these areas as well as the surrounding grey-scaled protected areas may be considered a 'megapark' that often stretches beyond international boundaries. Developing these megaparks as conservation units makes ecological sense because they provide for important ecosystem services such as water catchment and animal migrations.

CONTRIBUTION OF COUNTRIES TO SOUTHERN AFRICA'S ELEPHANT RANGE



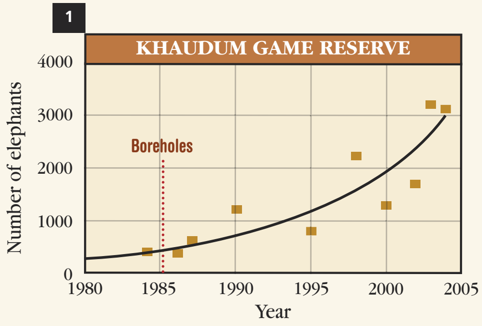
Elephants range unevenly over some 22 per cent (1.3 million km²) of the area of southern Africa

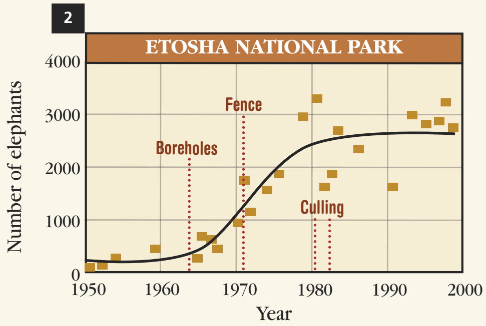
SOUTHERN AFRICA'S ELEPHANTS PER COUNTRY

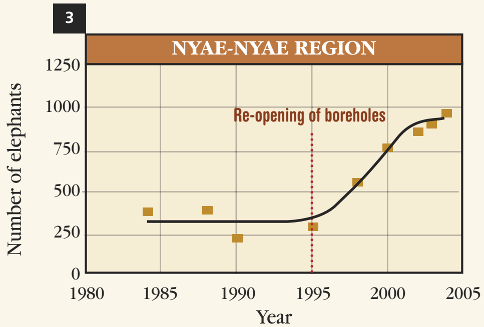


Based on the African Elephant Status Report (2007), some 280, 300 elephants lived in nine countries across southern Africa

Figures 1 - 3: Elephants respond to management interventions such as the provisioning of water by boreholes and the erection of fences. Water provisioning allows elephants to overcome the effects of drought and enhances survival. This and the attraction of elephants from elsewhere can boost population growth and numbers, as shown here for three populations in northern Namibia. In all three cases numbers increased nearly exponentially after the provisioning of water through boreholes.

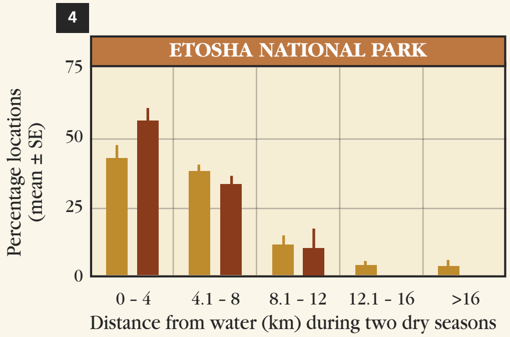


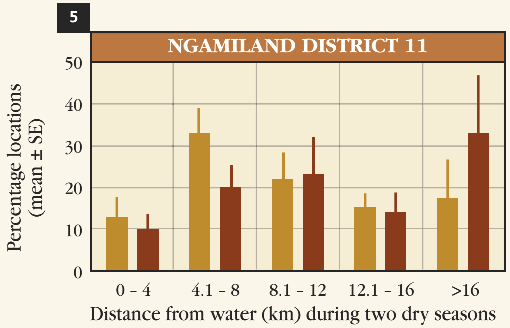


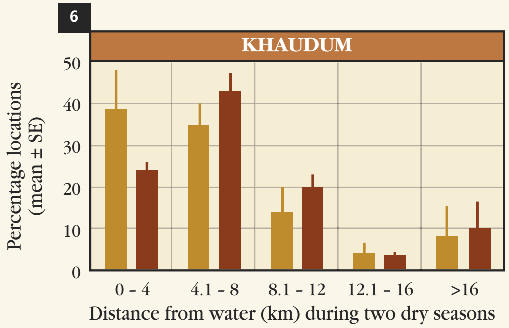


Data extracted from: Lindeque 1991, MET 2004, Martin 2005, www.nnf.org.na/RARESPECIES/InfoSys/Index.htm (Khaudom GR); Martin 2005, Blanc *et al.* 2007 (Nyae-Nyae Conservancy); Viljoen 1987, Viljoen 1988, Lindeque 1991, Loutit & Douglas-Hamilton 1992, Loutit 1995, Blanc *et al*. 2003, Blanc et al. 2007 (Kunene-Damaraland)

Figures 4 - 6: Satellite tracking studies show that elephants that live in areas where water is provided, roam over shorter distances away from water than those that live in areas not provided with water. This enhances impact on sensitive vegetation. These diagrams show that elephants stayed closer to waterholes in both the Etosha National Park and the Khaudum Game Reserve (Namibia) than those that live along the Okavango River (Ngamiland II) in Botswana.

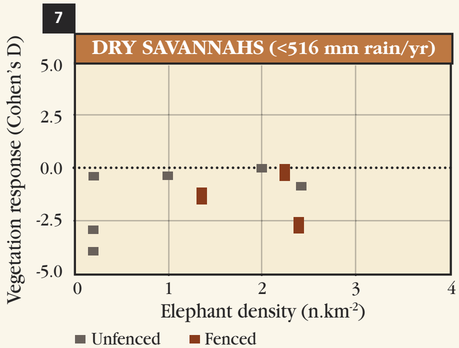


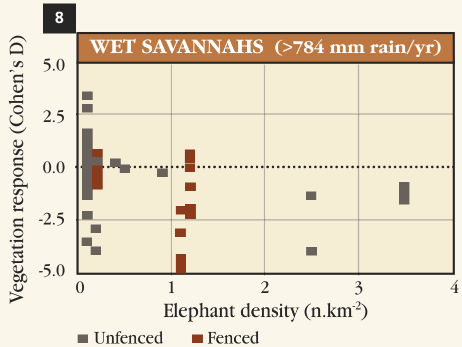


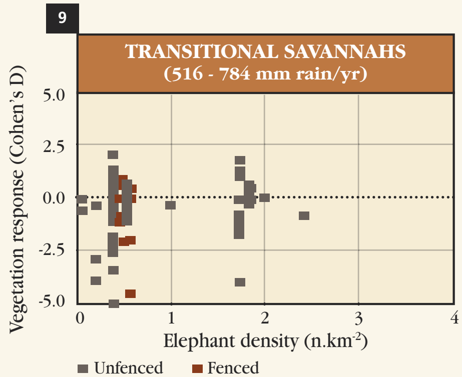


Based on de Beer Y & van Aarde RJ (2008) J. *Arid. Environ.* 72: 2017 -2025

Figures 7 - 9: Plants react either positively or negatively to being eaten by elephants. Scientists compare the responses of vegetation in different areas and studies through the so-called 'effect size', expressed by Cohen's D. Positive values denote positive responses and negative values, negative responses. We now know that these responses depend on rainfall as well as the density (number of elephants per square kilometre) and distribution of elephants. For comparable density and rainfall regimes, both negative and positive responses have been noted across a wide range of conditions. However, in fenced parks more negative than positive responses have been recorded, thus illustrating that fencing enhances the impact that elephants have on plants.



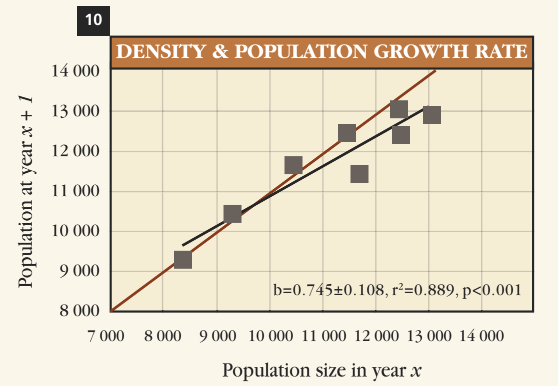




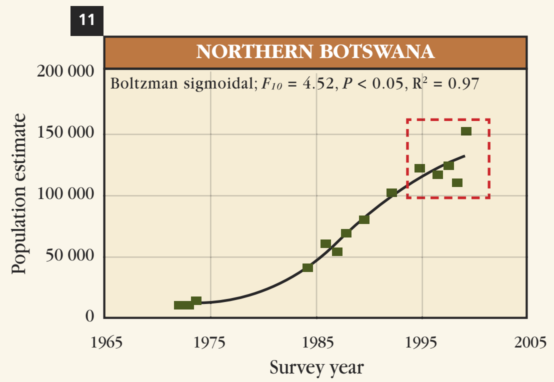
Based on Guldemond RAR & van Aarde RJ (2008) J. *Wildl. Manage.* 72: 892 - 899

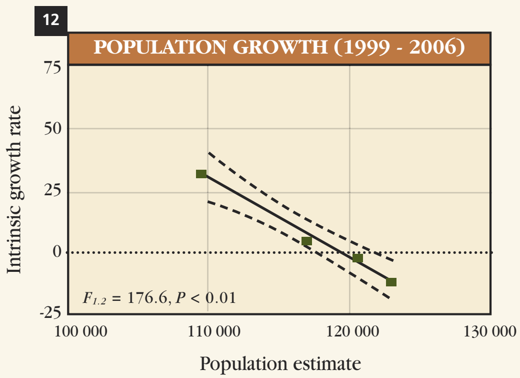
Figure10: The rate at which animal populations grow depend on the number of individuals in the population – simply put, the more the number of animals per unit area the slower the rate of increase. Competition, due to a shortage of food and space, may drive this relationship – over time and under natural conditions population sizes change little. Limited changes over time can be expressed graphically as a 1 to 1 relationship (denoted by the red line in the graph) between population size at time x and at time x+1. Yearly population counts of elephants in the Kruger National Park from 2001 to 2008 show that this population is tending towards zero growth. This may be due to density dependent drops in reproductive and survival rates, or due to elephants moving to vacant areas surrounding the park. The closing of waterholes may also add to this apparent density dependence.

Data provided by Dr SM Ferreira. SANParks



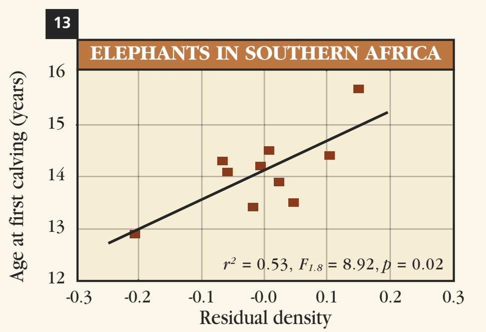
Figures 11 and 12: Most of southern Africa's elephants live in northern Botswana. Numbers here are no longer increasing rapidly and have stabilised at around 130 000, probably due to them dispersing to vacant areas and to a reduction in reproductive output and in survival rates. The clear relationship between growth rate and population size illustrated here, support the notion. Efforts to reduce the population may be met by increased growth rates, as has been recorded elsewhere.





Based on Jonker J, van Aarde RJ & Ferreira SM. (2008) *Oryx* 42: 58 - 65

Figures 13 and 14: When correcting density for rainfall, as expressed here by 'residual density' for elephants across southern Africa, it becomes clear that the age at first calving and the intervals between calving increase with an increase in the number of elephants per unit area. Rainfall can modify these relationships but by statistically removing the influence of rainfall on these reproductive variables, the effect of density becomes highly apparent. Management can alter this relationship and actions such as culling can thus enhance reproductive rates in elephants. (CERU Unpublished data)



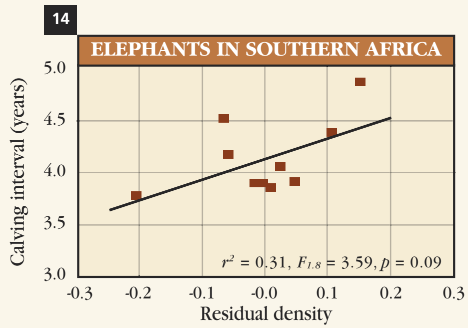
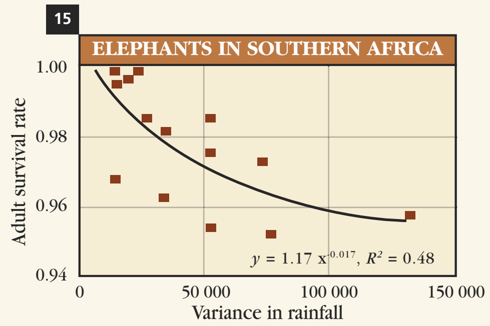
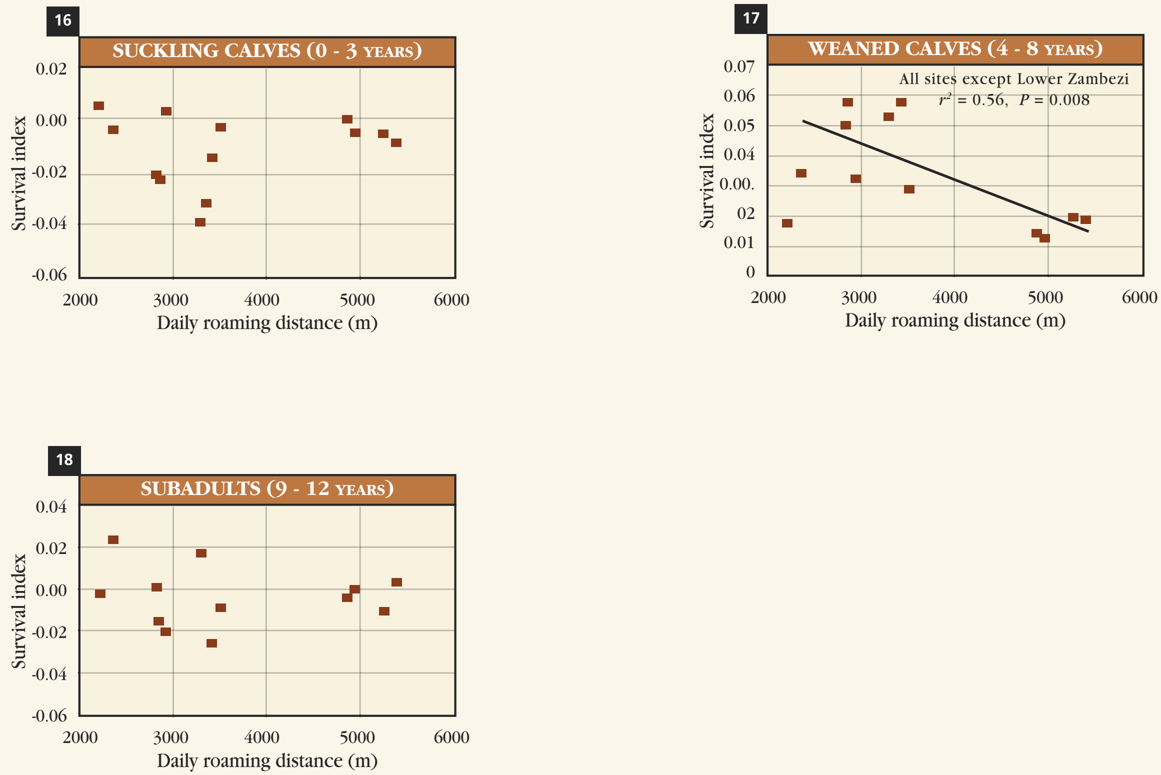


Figure 15: Elephants can cope with extreme environmental conditions, but droughts challenge survival rates. Study site-specific incidences of dry spells increase measures of variability in rainfall. In this diagram we use the variance of rainfall as a measure of the incidences of extreme conditions induced by low rainfall. Across southern Africa, elephant survival decreases with increasing rainfall and this has huge implications for population growth. Droughts that reduce the survival of adults may limit population growth. (CERU Unpublished data)

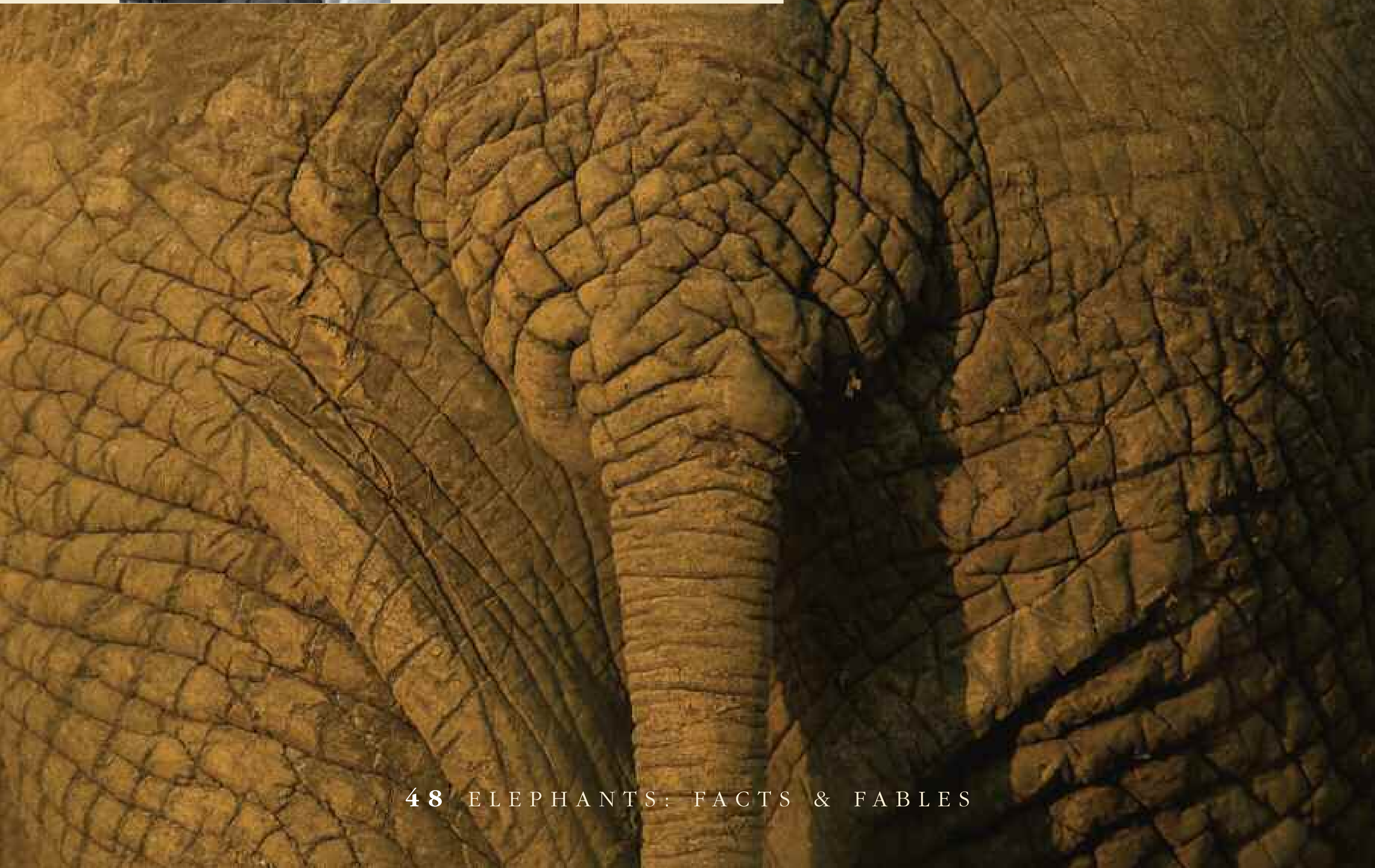


Figures 16, 17 and 18: Satellite tracking shows that the distances over which elephant breeding herds roam every day is determined by primary productivity (a measure of food availability), rainfall and by the number of elephants in the population. Consequently the distances over which breeding herds roam every day increase with reduced primary productivity and with increasing density. Young elephants (elephants less than 12 years of age) are stressed by the needs of their family herds to forage over wide areas. This is especially true for weaned calves in the 4 to 8 year old category (see diagram). This information suggests that changes in behaviour due to resource scarcity induces changes in population growth rates, most likely through the effects of elephant densities on roaming behaviour.



Based on Young K & van Aarde RJ (2009) J. *Anim. Ecol.* (accepted).

Professor Rudi van Aarde (PhD, FRSSAf) is a professor of Zoology and directs the activities of the Conservation Ecology Research Unit in the Department of Zoology and Entomology at the University of Pretoria. His research focus on elephants has contributed much to our present understanding of elephant conservation and management.



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