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The interactions between humans and mammals in Africa in relation to conservation: a review

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Most human–mammal interactions are detrimental to wild mammals. In Africa, mammalian population numbers and the geographical distribution of many species have been reduced due to hunting, pastoralism, habitat modification and disease control. The importance of each of these factors depends on the species, its location and habitat, and density of the human population. In contrast, some small- and medium-sized species have benefited from human activities, and there has been an increase in the population numbers of some species in well-managed and well-protected conservation areas. There appears to be a strong negative correlation (at least for some well-studied species) between density of humans and density of mammals. Recently, several African countries, notably in southern Africa, have developed the principle of integrated rural development in which local people are involved in the planning and administration of their traditional lands. Managed conservation areas are an integral part of good land-use policies. Surveys indicate that most Africans living close to conservation areas, especially those with a higher level of education, understand and support the ideals of conservation; nevertheless it is important that the benefits of conservation and integrated development (such as money, jobs, and food) directly benefit the local people. Conservation of mammals (and all other species) in Africa in the future will only succeed if there is participation at the 'grass roots' level, better food production in designated agricultural areas, reduction in the rate of increase of human populations, stabilization of human densities, and active programmes of conservation education.

Keywords: African mammals; conservation, human–mammal interactions; human densities; integrated development.

Introduction

Recent ecological studies have shown that the characteristics of populations, and the interactions beween organisms, are determined mainly by three principles:

(1) Competition – which occurs between individuals and populations, either directly for a specific resource or indirectly by interference during the utilization of a resource.
(2) Carrying capacity – which determines the biomass which can be supported by the habitat at a specific time without any adverse long-term effects on the habitat.
(3) Niche selection – which indicates the way in which organisms utilise the resources of the environment.

The characteristics of human and other mammalian populations may also be explained by these principles. However, in recent years, humans have considered themselves above, and immune from, the ecological laws which dictate the numbers and fates of other species.

This paper examines the inter-relationships between humans and mammals in Africa with respect to these principles, shows how these relationships have changed with time and location, and finally considers how African mammals may be conserved in the future. Recent reviews by Parker (1983), Lusigi (1984), Caro (1986) and McNeely (1990) also consider some of the topics discussed in this paper.

Interactions between mammals and humans

Humans and wild mammals interact in many ways; some of these are beneficial to humans, but others are non-beneficial or adverse to humans and to their domestic stock (see also Martin, 1986b; Parker, 1986). African mammals have been of great benefit to humans because they provide food, clothing, ornaments and (in recent years) revenue. On the negative side, some species of wild mammals damage crops, cause bodily harm, compete with domestic stock for fodder, and are alternative hosts for microorganisms which are pathogenic to humans and domestic stock. The magnitude and importance of these interactions are dependent on the species and number of individuals involved in the relationship, and on time and location. Many small- and medium-sized antelopes, for example, have been of immense benefit because of the meat and skins they provide, and their value far outweighs the limited damage they cause to crops. Elephants (*Loxodonta africana*) and some primates may be considered more destructive than beneficial to human endeavours, and the multi-mammate mouse (*Mastomys natalensis* group) which eats growing and stored crops and carries the virus for Lassa fever seems to have little beneficial value to humans. Thus African mammals may be categorized subjectively according to their perceived value to humans.

An alternative way of viewing the relationship is to consider whether mammals benefit, either directly or indirectly, from humans and how they respond to exploitation and competition. The criteria to assess this include the magnitude of the interaction, the 'value' of the species to humans, and (of lesser importance) the size of the mammal. Thus a large, common and highly valued species is likely to suffer to a greater extent (and its populations will decline accordingly) than a species which is small, rare and 'valueless'. Table 1 describes three responses to exploitation. There is no clear cut dividing line between each group, and our lack of knowledge concerning changes in population numbers over time for many species of African mammals prevents accurate assessment of the response of most species. Even so, it is obvious that many of the larger species belong to Group A; these are the species which are currently at the greatest risk. Many species in Group B are not adversely affected by humans *per se*, but there is little accurate information about these species. Most conservation initiatives, perhaps incorrectly at times, concentrate on Group A species and take lesser notice of Group B species. However, a Group B species may imperceptibly become a Group A species (without anyone noticing) as it becomes rarer or locally extinct. Besides the effects of exploitation, populations of many species in Groups A and B have declined because of competition with humans for a common resource, or by the loss of suitable habitat; the net result is that these species have not benefited from interactions with humans. In contrast to A and B, species in Group C have probably increased in range and numbers (on a continental basis) because they can utilise human-generated habitats; notable among such species are certain rodents (collectively called 'pests'!), and species of bats which can utilise human habitations and plantations as

Table 1. The responses of African mammals to human interference

Group (examples)	Response	Species characteristics	Reasons for response
A. Populations decrease (elephants, large/medium artiodactyls and carnivores, most primates)	Negative	• Large size • Low reproductive rate • Compete directly with humans/ stock for resources	• High value to humans • High trophy value • Cause damage • High monetary value • Competition for land • Hosts for diseases
B. Populations static (many medium-sized mammals, many orders)	Neutral	• Variable size • Moderate reproductive rate • Limited competition with humans/stock for resources	• Less value to humans • Limited value for trophies • Low monetary value • Limited competition for land • Not known as hosts for diseases
C. Populations increase (certain small rodents, shrews, bats, other small species)	Positive	• Usually small size • Usually high reproductive rate • Limited competition with humans for resources, or good at exploiting human resources	• No value or limited value to humans

roosting sites. Thus, as competition theory predicts, there are negative, positive, and neutral outcomes. These inter-relationships have several consequences:

(1) Population numbers of many species have changed over time, and community structure has altered.
(2) Many aspects of ecosystem dynamics have been modified as a result of the alterations in community structure, especially cycling of energy and nutrients, exploitation of plant resources, and structure of food webs.
(3) There has been a reduction in the numbers of dominant and keystone species.

How humans have affected mammalian populations

There are numerous ways in which the activities of humans affect mammals. The effects of these are additive and perhaps synergistic; it is the total effect which is important (rather than the effect of any particular one). The most important of these activities, considered below, are hunting for food, pastoralism, habitat modification, and disease control.

Hunting for food

Hunting mammals for food is an age-old activity of humans. When human populations were much smaller than they are now, hunting probably had no long-term adverse effects on any species. As human population numbers gradually increased, larger species (which provide more meat per unit time of hunting) declined in numbers and geographical range, although smaller species have been remarkably resilient to the effects of hunting. Asibey (1974, 1977) has documented the enormous amounts of 'bushmeat' which are eaten in selected countries of West Africa. In Ghana, most of the species on sale in markets are small probably because these species are common enough to justify the time spent in hunting them (Table 2). Meat from these species provide valuable protein to local people in many countries (e.g. Nigeria (Charter, 1971; Martin, 1983; Happold, 1987; Adeola, 1992), Ghana (Asibey, 1974), Liberia (Jeffrey, 1977), Zaire (Wilkie and Finn, 1990), and Senegal (Cremoux, 1963)) especially in rural regions where meat from domestic stock is unavailable or expensive. However, bushmeat may be more expensive than beef, especially in towns, where it is a delicacy rather than a source of protein. Meat from wild mammals still forms a significant part of the diet in hunter-gatherer societies of Zaire (Hart and Hart, 1986) and north-eastern Gabon (Lahm, 1993).

Unfortunately, there are no long-term studies to show whether the availability of bushmeat has changed over the years, whether the species composition of bushmeat has altered, and whether the time-budget of hunters has changed with time. However, reduction of habitat suitable for bushmeat species, an increase in demand for bushmeat, the ease of reaching previously remote regions in recent years, and changing economic conditions have undoubtedly caused a decline in the population numbers of many bushmeat species. For these reasons, Asibey (1977) advocated careful management of these species.

Pastoralism

Pastoralism has always been of great socio-economic importance in many savanna regions of Africa (Mordi, 1989). Pastoralism is a form of interference competition because wildlife feed on vegetation which could be eaten by domestic stock, and vice-versa. The influence of pastoralism on wildlife is contentious because it is difficult to assess the impact of wildlife on domestic stock (Table 3). Ultimately, the numbers of humans, cattle and wild mammals that can be supported in a given region is determined by the carrying capacity which fluctuates from year to year depending on the rainfall and previous grazing pressure. Brown (1971) argued that the number of pastoralists in an ecosystem (and hence the

Table 2. Species of mammals commonly sold for bushmeat in West African markets (based on Asibey 1977; Martin 1983; Happold 1987)

Cane Rat	(*Thryonomys swinderianus*)
Duikers	(*Sylvicapra grimmia* and *Cephalophus* spp.)
Bushbuck	(*Tragelaphus scriptus*)
Pouched Rat	(*Cricetomys gambianus*)
Bush Pig	(*Potamochoerus porcus*)
Monkeys	(mainly *Cercopithecus mona* and *Cercocebus torquatus*)
Palm Civet	(*Nandinia binotata*)

Table 3. The influence of pastoralism on wild mammals

Viewpoint 1 (Brown 1971; Poins 1992)	Viewpoint 2 (Homewood and Rodgers 1987)
• Cattle compete with mammals for forage	• Cattle and mammals can co-exist because of niche separation
• Cattle cannot co-exist with wild mammals	• Cattle may co-exist with wild mammals
• Too many cattle cause ecological degradation	• Cattle do not cause long-term degradation, even though pastures may look overgrazed at the end of the dry season
• The number of pastoralists must be limited to conserve the pastoral way of life	• The number of pastoralists may increase (within limits) without adverse effects

number of cattle they require) must be controlled. Pastoralists themselves have a vested interest in their own population numbers because too many of them (and therefore too many cattle) can jeopardize the pastoral way of life. Brown's view was that too many pastoralists lead in time to environmental degradation. Although Brown did not view pastoralism from the point of view of wild mammals, there appears to be an inverse relationship between population numbers of humans/domestic stock and populations of wild mammals. The low population numbers of larger mammals in West African savannas may be due to this inverse relationship (Jewell, 1980; in Homewood and Rodgers, 1984), but may also be due to the low nutrient status of the soils and vegetation (R. H. V. Bell, personal communication). In any discussion of pastoralism, it is necessary to appreciate that it is the combined biomass of humans, cattle and wildlife that should be considered, and that this biomass must oscillate as the carrying capacity oscillates. Thus conservation of wild mammals in pastoral country depends partly on the management of pastoralists.

Poins (1992) also takes the view that pastoralism, in excess, has detrimental effects on wildlife. In several areas of Kenya and Tanzania where wildlife and domestic stock coexist, livestock are responsible for most of the energy consumption leaving very little for wildlife. The assumption is that livestock (with their attendant herdsmen) compete successfully with wildlife, and competitive exclusion of wildlife is the inevitable result.

An alternative view of pastoralism is given by Homewood and Rodgers (1987). These authors cite the case of Ngorongoro Conservation Area (NCA) where Masai pastoralists coexist with large populations of mammalian grazers, and question the assumption that uncontrolled growth of domestic stock inevitably leads to increased competition with wildlife, overgrazing, and environmental degradation. Homewood and Rodgers make the following points:

(1) Although cattle numbers have fluctuated in the NCA, there is no consistent upward trend in numbers even though human numbers have increased.
(2) Domestic stock compete only with certain wild species at certain times, and not with all species all the time. Cattle and wildlife migrate, and herdsmen keep their cattle away from wildebeest (because of the danger of transmission of diseases to the cattle) and therefore avoid competition. Therefore competitive exclusion occurs only on a very local scale.
(3) Although grass cover is low at the end of the dry season (giving the impression of overgrazing to the inexperienced observer), subsequent rains induce sprouting of

annual and perennial grasses. Conversion of grasslands from mixed palatable grasses to perennial unpalatable grasses (a sign of overgrazing) has not occurred in the NCA (Homewood and Rodgers, 1987).

However, the NCA has a particularly high primary productivity because of the high fertility of the soil, and thus may not be typical of most of Africa.

Habitat modification

Human activities have caused massive changes to the character and functioning of African ecosystems. The most important of these have been associated with agriculture, grazing and timber production; all have resulted in environmental degradation to varying degrees because of the reduction of tree cover and fertility, and an increase in soil erosion. As a result, natural habitats have been extensively modified to make them more suitable to sustain humans and less suitable for wild mammals. Empirical data on the rates of change of land-use, and the consequent changes in mammalian populations, are hard to obtain except for certain 'high profile' species which immediately capture human sympathy and emotion (e.g. elephant, gorilla [*Gorilla gorilla*], and rhinoceroses [*Diceros bicornis* and *Ceratotherium simum*]). However, three obvious points need to be made:

(1) The greatest concentrations of mammals at the present time are found only in reserved areas. These cover about 7% of the African land surface (range < 1% in Gambia to 24% in Uganda and 29% in Zaire [IUCN, 1987]). These percentages compare favourably with many other countries of the world.
(2) Larger mammals are now rare outside reserves compared with earlier years.
(3) Marginal habitats of low soil fertility which are unsuitable for agriculture can support good populations of mammals provided there is no human interference.

Agriculture and deforestation are the principal causes of habitat modification. The area of land used for agriculture and permanent crops has increased in all countries of Africa since 1950 by about 26% (Bilsborrow and Ogendo, 1992). This increase has been necessary to provide food for the increasing human populations (see below). Most African countries (except very small countries with a high density of humans) have less than 15% of their land area in agriculture, and only eight of the 34 subsaharan countries have more than 15%, e.g. Nigeria 33%, Burundi 50%, Rwanda 39%, Uganda 28% (Bilsborrow and Ogendo, 1992). Such figures do not state what these percentages are in relation to potential agricultural land, nor what criteria might be used to assess potential agricultural land. However, increase in new agricultural land has not normally provided more food per person because of the rapid increase in human population numbers (see below). These data suggest that there is additional land for agriculture even though some of it may be unsuitable because of adverse climate, poor soil, and potential for erosion. Although denied by some commentators, wild mammals (especially the larger species) and agriculture do not mix.

Deforestation is the second major form of habitat modification in Africa. The average annual percentage 'deforestation' during the 1980s was about 0.5%–2.9%/year (Barnes, 1990) according to country, equivalent to about 5%–30% per decade. Again, the rate of deforestation appears to be highest in countries with the highest densities of humans. Deforestation eliminates habitats necessary for the survival of most species of forest

mammals; at worst, it results in local extinction of forest species unable to adapt to changing conditions.

The effects of changes in land-use, primarily agriculture and deforestation, are indicated dramatically by the contraction in geographical range of many species. The best documented examples are elephant and black rhinoceros in East Africa (Fig. 1); such maps are not untypical of many other larger mammals, and in other parts of Africa. Contraction in range is one of the most adverse effects that humans have had on mammals in recent years.

Often habitat modification by humans has local but very profound effects. The ecology of floodplains, for example, is influenced by the seasonal rise and fall of the water level in the floodplain. In Zambia, construction of hydro-electric dams on the Kafue river has altered the seasonal pattern of river flow on the flats downstream of the dams (Sheppe, 1985). Prior to the dams, the flats were flooded during and immediately after the wet season and all the mammals had to move to higher ground. During the dry season, the waters subsided and mammals recolonized the flats; thus the flats alternated between a huge lake with no mammals, and extensive grasslands full of mammals. During the dry season, the flats were heavily grazed and utilized, but during the wet season, they were replenished with nutrients and silt in the floodwaters. Since the dams were built, the flats upstream are permanently flooded; seasonal movements of mammals onto the floodplain

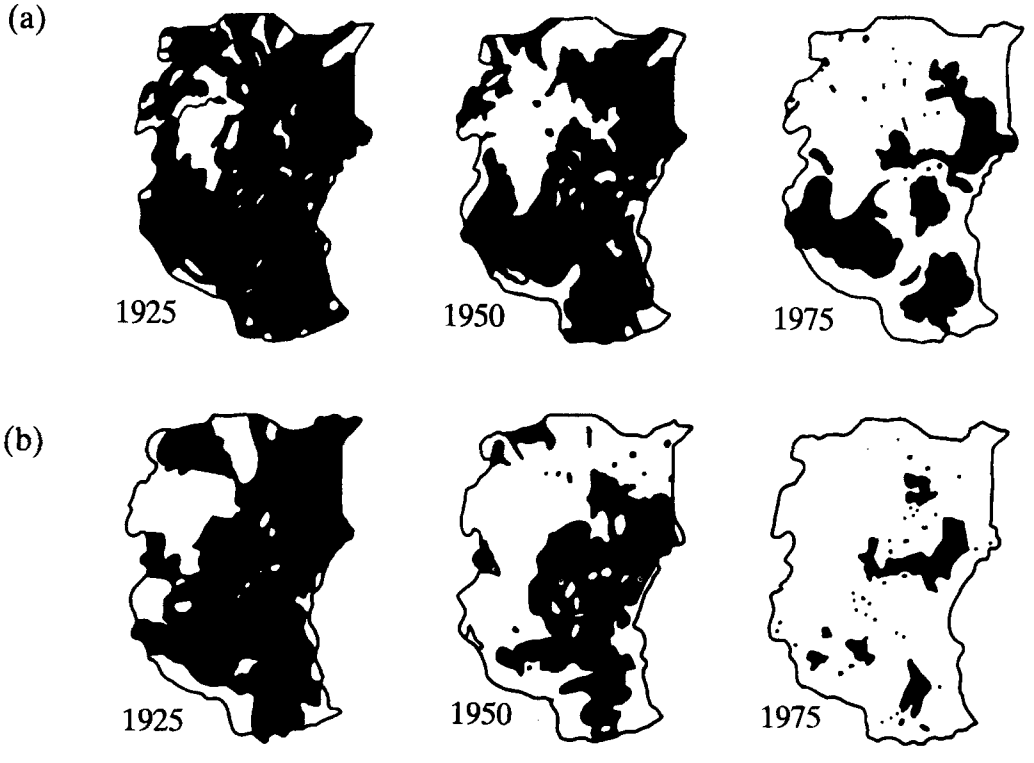

Figure 1. The geographical range of (a) elephant and (b) black rhinoceros in East Africa in 1925, 1950 and 1975 (from Parker and Graham, 1989c, after Kingdon, 1979; reproduced by permission of the Zoological Society of London).

to feed on the nutritious sprouting grass are no longer possible so grazers are confined to the higher ground which do not experience the lush growth of the former plains. The result is that the larger grazing species (e.g. puku (*Kobus vardoni*), lechwe (*Kobus leche*) and smaller species (rodents and their predators) have declined in number. Downstream, the grasslands are not flooded (except very occasionally, and not at the 'natural' time), grasslands have given way to thickets, silt and nutrients are not replenished, and mammals graze on the plains throughout the year. Grazing pressure is maintained all through the year, and the normal 'grazing cycle' has been destroyed. This single example (and there are many others (see e.g. Attwell, 1970; El Moghraby and El Sammani, 1985)) shows that a major human enterprise can cause huge, but local, changes in the environment which result in major changes to the structure, numbers and resource utilization of mammalian communities. The justification for such enterprises is that they have, on balance, more benefits than disadvantages for human well-being.

Disease control

Conflict between humans and wildlife has been particularly acute in localities where wildlife were assumed to be alternative hosts for diseases. Trypanosomiasis transmitted by tsetse flies has an extremely severe effect on cattle in savanna habitats (see Matthiessen and Douthwaite, 1985). About 30% of the 147 million cattle and about 50 million humans are exposed to possible infection of trypanosomiasis (Murray and Njogu, 1989), but the real cost of the disease, in terms of mortality and debilitation, is difficult to quantify. The 'standard' solution to control the spread of trypanosomiasis, in addition to spraying chemicals to kill adult tsetse flies and clearing of bushland to remove preferred habitat for adults, was to shoot wild mammals. All species were shot indiscriminately until it was realized that not all species are important hosts. From 1930 to 1953, in Zimbabwe, over 550 000 game animals were shot in an effort to control trypanosomiasis (Tomlinson, 1980). Similar control measures were taken in many other countries, e.g. Botswana (von Richter, 1970), and Uganda (Wooff, 1968, in Delany and Happold 1979). These measures produced local reductions in the incidence of trypanosomiasis, but the general pattern and importance of the disease has not changed substantially over the years (Rogers and Randolph, 1988). Although mammalian populations were drastically reduced in some areas, some individuals remained and populations were able to increase again. Most writers on tsetse flies and trypanosomiasis consider only the adverse effects of the disease on humans and cattle; an alternative view is that tsetse flies have had a beneficial effect because they have controlled the spread of human settlement and development, and conserved habitats suitable for wild mammals. It is a well-known fact that habitats which have an abundance of tsetse flies also have flourishing populations of the larger species of mammals.

These four interactions illustrate the uneasy relationship between mammals and humans in Africa. On one hand, humans benefit from the wild mammals in many ways; on the other hand, humans have the capacity to decimate wild mammals in order to obtain this benefit. In historical times, there was a balance between these conflicting situations: the huge size of the continent, the small human population, and the inability of humans to settle and survive in some regions, all helped to reduce conflict. Now, the balance has shifted against mammals, and it is necessary to seek new ways to promote a harmonious relationship between humans and mammals.

Humans, domestic animals and food production

Demographers and statisticians have provided long-term data on the characteristics of human and domestic animal populations in Africa, and on each African country (Fig. 2). Although the data are slightly 'woolly' because of the immense difficulties of making accurate censuses, they show several very obvious trends (United Nations 1973, 1981, 1990; FAO 1976, 1983a, 1989). During the period 1965–1990:

(1) Population numbers of humans have increased from about 300 million to about 640 million, and are still increasing. This represents a gross annual increase of about 2.5%, i.e. a doubling of the population in about 30 years.
(2) The rate of increase varies in different countries from about 2.4% (e.g. Equatorial Guinea) to about 3.3% (e.g. Nigeria) (1985–1990 data).
(3) Population numbers of cattle have increased from about 130 million to about 185 million, and shoats (sheep and goats) have increased from about 252 million to about 370 million, an increase of about 50%.

Each African country shows the same trend as for the whole continent, with some variations. Two countries, Zimbabwe and Malawi, have been selected to illustrate these trends (Figs 3, 4). In Zimbabwe, the human population is now about 9.4 million, an increase of × 2 since 1965. This is equivalent to about a density of 19 humans km^{-2}, which is comparatively low by African standards. There are now about 6.5 million cattle (an increase of × 1.8 since 1965) and about 3.1 million shoats (an increase of × 3.8). During the same period, the production of food has nearly doubled although the annual rate of production has varied greatly. However, this increase has not kept up with the increase in human numbers, and the production of food per person has declined. In Malawi, a small country with one of the highest densities in Africa (65 humans km^{-2}), the population is currently about 8.2 million (an increase of × 2 since 1965). There are 1.1 million cattle (an increase of × 2.9) and 1.2 million shoats (an increase of × 2.6). For most of the last 25 years, food production has increased at a faster rate than the increase in human numbers, although in the last few years (partly because of severe droughts) food production per person has declined slightly. In both countries, as in Africa as a whole, food production per

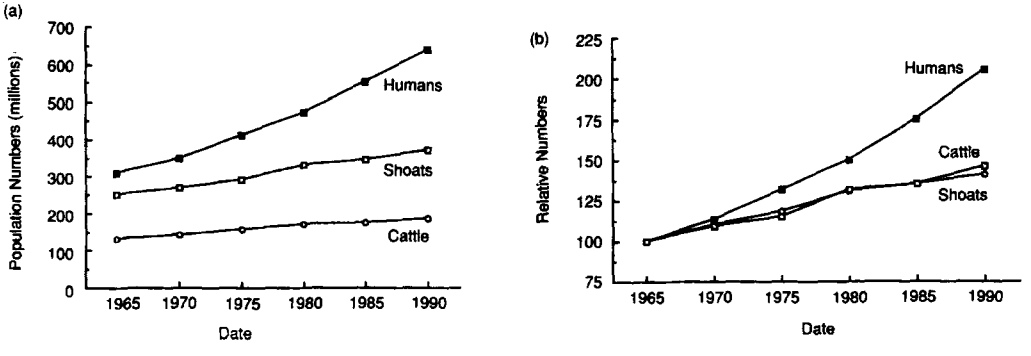

Figure 2. (a) Population numbers of humans, shoats, (sheep and goats) and cattle in Africa from 1965 to 1990. (b) Relative numbers of humans, shoats, and cattle in Africa from 1965 to 1980; 100 = 1965. (Data from United Nations, 1973, 1981, 1990, 1991.)

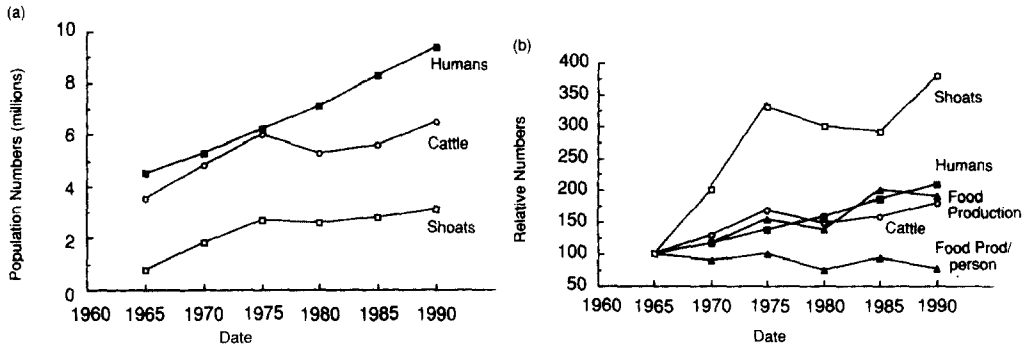

Figure 3. (a) Population numbers of humans, cattle and shoats (sheep and goats) in Zimbabwe from 1965 to 1990. (b) Relative numbers of humans, shoats, and cattle in Zimbabwe from 1965 to 1980; 100 = 1965. (Data from FAO, 1976, 1983, 1989; United Nations, 1973, 1981, 1990, 1991.)

person has declined in recent years even though there has been a slight drop in the annual rate of increase of humans (e.g. in eastern Africa the rate was 2.58% in 1970–1975, 2.96% in 1975–1980, and 2.81% in 1980–1985 (United Nations, 1985)). Surprisingly, the land area devoted to agriculture and permanent crops has not increased at the same rate as human populations have increased. The increase in yields per hectare has been mainly due to the widespread use of imported inorganic fertilizers and new high yield strains of crops. Nevertheless, food production per hectare in Africa is low by international standards (United Nations, 1985; see also FAO 1984).

The increase in human numbers in the last 25 years, especially, has placed a considerable strain on African ecosystems and is likely to increase during the coming years; the effects of this on mammals has been drastic and is considered in more detail below.

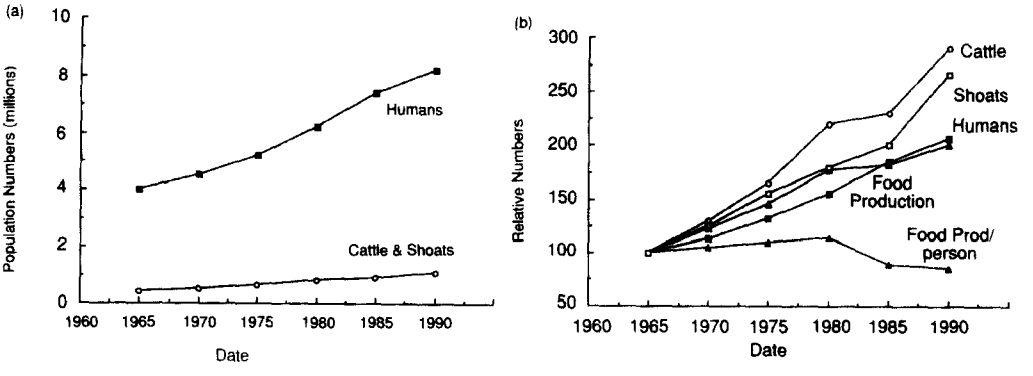

Figure 4. (a) Population numbers of humans, cattle and shoats (sheep and goats) in Malawi from 1965 to 1990. The numbers of cattle, and of shoats, are similar and therefore the graphs are superimposed (b) Relative numbers of humans, shoats, and cattle in Malawi from 1965 to 1980; 100 = 1965. (Data from FAO, 1976, 1983, 1989; United Nations, 1973, 1981, 1990, 1991.)

Table 4. The consequences of increasing numbers of humans and domestic stock on wild mammals

1. Increase in interference and resource competition
2. Increase in exploitation
3. Decrease in area of natural habitats suitable for mammals
4. Increase in area of agricultural and human environments
5. Decrease in the numbers and geographical ranges of many species of mammals

Mammalian populations

For most species, there is little accurate historical data on population numbers and on their changes over time. The increase in human numbers has resulted in multiple effects on mammals (Table 4). On a continent-wide basis, there has been a reduction in the numbers of the larger species of mammals. However, this is not a general trend because mammalian populations in National Parks and reserves have not necessarily shown the same decline; in fact, populations of different species have both increased and decreased depending on environmental conditions. There is less information for the smaller species, although it is generally assumed that habitat changes have also been responsible for reductions in the numbers of some of these species. Parker and Graham (1989a, b, c) have shown that there is an inverse relationship between the density of humans and the density of elephants in various regions of Zimbabwe (Fig. 5) and Kenya. This is because humans and elephants have similar environmental requirements, and hence competitive exclusion of elephants will occur in preferred habitats when the density of humans reaches a critical level. Other studies have shown that the biomass of larger mammals, and therefore population numbers, increases with increasing rainfall in savanna regions of low and moderate rainfall (Coe *et al.* 1976), more so on fertile soils than on less fertile soils (Bell 1986a). Parker and Graham (1989a) showed that elephants do not occur when human density is $> 82\,km^{-2}$ in Kenya (rich soils) and $> 18.5\,km^{-2}$ in Zimbabwe (less rich soils). The converse of these

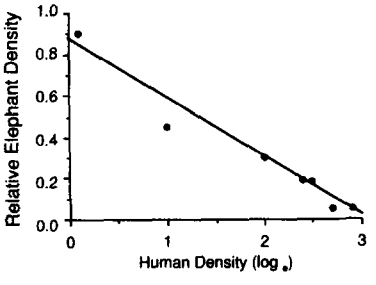

Figure 5. The relationship between the density of elephants and the density of humans in seven regions of Zimbabwe (from Parker and Graham, 1989c; reproduced by permission of the Zoological Society of London).

relationships is that elephants will be most numerous where human densities and activities are low or absent (Burrill and Douglas-Hamilton, 1987).

Although elephants have declined in Africa as a whole (from about 1 300 000 to 500 000 during the 1980s – see Douglas-Hamilton, 1987, for a review), the population numbers and rate of change varies greatly according to locality and conditions (Fig. 6). In some areas, elephants have increased in numbers, and in others they have declined. In general, regions where elephants have declined are characterized by poaching, civil war, changes in land-use, and increases in human densities. In contrast, elephants have increased in areas which are strictly managed and where human interference and competition is minimal. In other regions (e.g. Kasungu National Park in Malawi during the period 1982–1992 (R. H. V. Bell, personal communication, 1993)), elephant populations have remained stable. Thus the inter-relationship between elephants and humans is equivocal and complex. These observations generally confirm the validity of Parker and Graham's regression, and indicate that elephants are a very sensitive 'barometer' for measuring human–mammal interactions. Regressions for other species, if they were available, would probably show the same trend. This single example exemplifies the basic relationship: that is, increase in human numbers, interference and exploitation result in conflict,

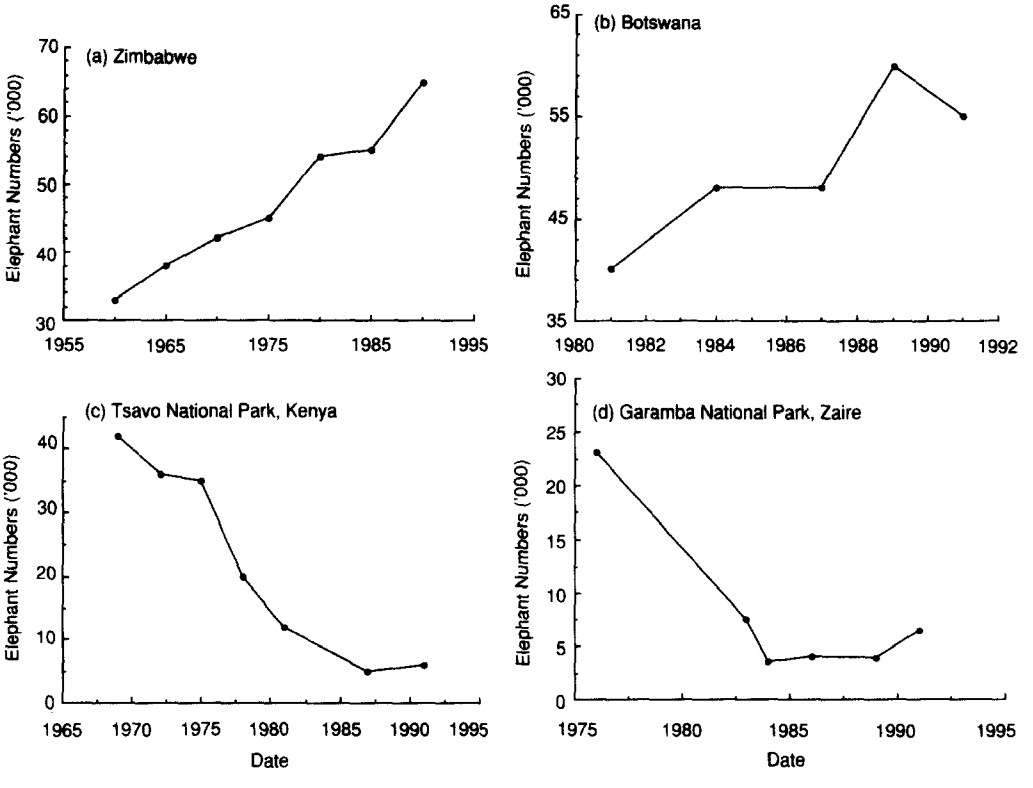

Figure 6. The population numbers of elephants in four regions of Africa: (a) Zimbabwe, (b) Botswana, (c) Tsavo National Park, Kenya, (d) Garamba National Park, Zaire. Note the difference in the time scale and population numbers of each graph. (Data from Cumming *et al.*, 1990; Douglas-Hamilton *et al.*, 1992.)

competition, and decline of mammalian populations. This is not an unusual situation; it has occurred in many other continents in the past.

Primates are also vulnerable to the effects of human activities (Oates 1977a, b, 1986; Skorupa, 1986; Johns and Skorupa, 1987; Marsh *et al.* 1987; Oates *et al.* 1987). The populations of many species, especially rainforest primates, have changed due to various forms of human disturbance including:

(1) Deforestation by commercial logging, which reduces the geographical ranges of most forest species.
(2) Clearing for agriculture, which reduces tree density and plant species richness (even though the habitat may still appear to be forested). Subsequent burning of the undergrowth prevents forest regeneration.
(3) Removal of selected species of trees which form an important part of the diet of primates.
(4) Construction of dams, with the consequent flooding and loss of riverine forests.
(5) Shooting for food, trophies, and medicines.

In general, the number of species and population numbers of primates increase with increasing species richness of trees. Consequently, reduction in the quality and extent of forests reduces the population numbers of primates. However, species are very idiosyncratic in their responses to the effects of humans. In Kibale Forest in Uganda, for example, the numbers of mangabeys (*Cerocebus* spp.), red colobus (*Colobus badius*) and chimpanzee (*Pan troglodytes*) declined with increases in forest disturbance, whereas the numbers of guereza (*Colobus abyssinicus*) increased (Skorupa 1986). Decline in numbers is often associated with changes in home range area, group size, and other socio-ecological characteristics. Many species can probably maintain reasonable populations in medium-logged forests which are properly managed, and provided logging is not associated with an increase in hunting (Johns and Skorupa, 1987).

The African view of conservation

In Africa, conservation is frequently considered to be an alien concept, only applicable to wealthy Western countries. An African family which is undernourished, living in poor conditions, and with little income, can hardly be expected to embrace an ideal which is based on beauty, aesthetics, and the future. Survival, today and tomorrow, has understandably a much greater priority. Until very recently, conservation rarely considered the wishes and aspirations of local people; conservation was forced upon them for the 'general good' of the country, or for some political reason which they could not understand. This approach frequently caused antagonism and generated ill-feeling towards conservation areas, promoted poaching and trespass, and made it more difficult to accomplish the aims of conservation. Several recent studies have investigated the views of local people living close to conservation areas with large populations of mammals. For example, a survey in Tanzania (Newmark *et al*, 1993) showed that 71% of 1190 people approved of a reserved area mainly because it generated revenue (41%) and protected wildlife (12%). The fact that the reserve protected watersheds and provided employment were rarely appreciated, and the role of conservation agencies and their employees was ambivalent. The 7% who were not in favour of the reserve stated that they received no

benefit from the conservation area, and would have preferred the land to be used for agriculture and firewood collection. These views are similar to those of a study in Natal (Ingfield, 1988). A slightly different view was recorded in Zambia, where the local population directly benefited from the Upper Lupande Game Management Area (ULGMA) (Balakrishnan and Ndhlovu, 1992) because wildlife conservation and management is integrated with the local rural economy. The main findings of this study were that 65% of local residents (n = 135) thought that they benefited to a greater extent than outsiders, and that the best form of wildlife utilization is culling which provides meat and skins and helps to protect crops, and the least valuable is 'safari hunting' because the revenue does not remain in the local economy.

Although the views of local people vary in different regions and different studies (see also Harcourt *et al.*, 1986), the following generalizations may be made:

(1) Many local people understand and appreciate the value of wildlife and conservation issues.
(2) There is frequently inadequate liaison between conservation agencies and local people, or an appreciation of the role of agencies and their employees.
(3) Appreciation of the value of wildlife and conservation increases with increasing affluence and socio-economic status.
(4) Benefits from wildlife utilization, such as better roads, schools, medical facilities, employment, and services at a price which local people can afford, must accrue to local residents.
(5) Wildlife should be regarded as part of the rural economy and therefore wildlife management and utilization should be integrated with other forms of rural development.

These viewpoints give rise for hope, and suggest that local attitudes are not totally negative. However, even a small proportion of a local population who engage in poaching and other illegal activities may have very detrimental effects on mammals (both rare and currently common species) and ruin rural development for the majority of the population. Conservation of mammals in modern Africa is possible only if the problems which have led to the present situation are identified and solved.

New initiatives for conservation of mammals

Most of the new initiatives which have been suggested in the last few years concern economics and land-use management, and how to develop the best compromise between the needs of humans and the needs of wild mammals. Clarke and Bell (1986) have proposed a framework to reduce conflict between humans and wildlife; they suggest three parameters – wildlife, land, and interaction – each of which assumes a different importance according to the stated objectives of each land-use zone. Within this framework, the following must be taken into account: (1) number of humans, livestock and agriculture, (2) infrastructure, (3) allowable changes to the ecosystem (resources) and (4) density of wildlife.

Allocation of land must also be dependent on soil fertility, with the most fertile soils being dedicated to agriculture and livestock production, and the least fertile soils to non-agricultural uses (Martin and Taylor, 1983). It has to be recognized that humans must

have priority in some regions of Africa, and that in these regions mammals are incompatible with rural development. In contrast, other regions should not be so human-orientated and may be developed as either a mixture of rural development and wildlife management, or solely for the conservation of wildlife. The prerequisites for the conservation of African mammals, which are sensitive to the needs of both humans and mammals, are considered below.

National parks and reserves

There is certainly a place for National Parks, Game Reserves and other reserved areas. Africa currently has about 7% of its land area in National Parks and other reserved areas, more than in any other continent other than North America. These are important for conservation of mammals (and other organisms) as well as being 'ecological banks' for the future. Care must be taken that they do not become isolated islands. However, reserved areas alone are inadequate to ensure long-term conservation of mammals.

Integrated management of rural development

Integrated management is based on local participation in the planning, development and maintenance of projects, and utilises all the resources of the region to the best advantage on a sustained yield basis (see Bell, 1987). Mammals (and other natural resources) are viewed as renewable resources, and suitable habitats are maintained to ensure the survival of these resources. The benefits (meat, skins, revenue from hunting, natural food) go directly to the community whose land participates in this form of rural development. Integrated management of this sort only works if there is decentralization and autonomy, and is not viewed favourably by centralist politicians who would prefer all profits to go to a central revenue. Nevertheless, integrated rural development will only work if the local community benefits. Such management programmes increase the land area where mammals have a chance to survive, and therefore have potential benefits for mammalian conservation. There are other advantages as well:

(1) Water catchment areas may be enlarged, ensuring permanent and clear water supplies.
(2) Agriculture is prevented on marginal lands (which are not suitable for agriculture and would have low productivity for only a few years at best).
(3) Other renewable resources may be harvested (thatch, nuts, fish, honey, etc. see Bell, 1986b).

There have been a number of successful experiments in integrated rural development in recent years. All have provided benefits to local people, and have enabled mammalian populations to grow. The best known of these experiments (see also Bell, 1987) are the Sebungwe regions and the CAMPFIRE project in Zimbabwe (Martin and Taylor, 1983; Child, 1984; Martin, 1986a), Amboseli in Kenya (Western, 1984), integrated management programmes in Zambia (Abel and Blaikie, 1986), as well as others in Ethiopia (CWO, 1983, in Bell, 1987), and Botswana (von Richter, 1970). These initiatives have legalized the value of wildlife and have, *inter alia*, increased the importance of wildlife in the national and local economy. They have also resulted in much better conservation and management of all natural resources. They are extremely good examples of the way in which local people can be involved in planning and conservation of wildlife resources.

Increase in agricultural production in defined agricultural areas

Increase in food production in Africa has been due to higher yields per ha, new high-yield strains of staple foods, and increased use of inorganic fertilizers (Harrison, 1987). This has been accomplished without an enormous increase in agricultural land (average 26% on 1950 values, see above) because of new farming and production methods; these include zero-tillage, agro-forestry, mulching, limited irrigation, fish-farming, intensive meat production, and fuel-wood plantations. All these methods utilise the land more effectively. However, production per person has not increased because of the increase in the number of humans; in fact, on average, every African has slightly less food now than 20 years ago. Nevertheless, these initiatives prevented an unacceptably large decline in food production per person. Good agricultural land must be developed to maximize sustainable high-yield production, so that less productive lands are available for other uses. These initiatives have also assisted conservation of mammals because they reduce the pressure on marginal lands which otherwise might have been turned into farms, and conform to the idea of integrated rural development and multiple land-use.

Reduction in the rate of increase of human population numbers and stabilization of numbers

Many commentators link the increase in humans with the decline in the numbers of wild mammals. Although there is a view that human populations may have been larger in Africa prior to 1700 than now (Bell, 1987), many aspects of life then, such as simpler life-styles, lack of firearms and very limited trade in wildlife products overseas would have reduced the impact of humans on mammals, and the influence of such large human populations can only be surmised. Human activities have undoubtedly caused a decline in mammalian populations in Africa during recent decades, as they have in other continents, and future increases in human populations will further reduce the abundance and geographical ranges of many species of mammals. It is essential, therefore, for the well-being of both humans and mammals, that there are renewed efforts to control human numbers, reduce the birth rate, accelerate the demographic transition, and reduce the economic necessity for having large families.

Research

The importance of research is self-evident to biologists, conservationists and land-managers. However, many current research projects, although excellent in their own right, are not directed towards a better understanding of ecosystems and more effective conservation and utilization. This situation could be remedied by a change in research priorities. Firstly, more emphasis needs to be placed on common ecosystems and their faunas; such ecosystems are widespread and support large numbers of species and individuals. This does not mean that rare species and small endangered ecosystems should be neglected, but it must be appreciated that in terms of area and numbers, humans have more interactions with widespread common mammals than with rare species. Secondly, there is a great need for 'experts' to write simple instructive books, guides and brochures on the identification and biology of common and/or important mammals; such publications should be specific to a country or conservation area. They should be inexpensive and readily available to anyone in Africa, particularly in schools, colleges, National Parks and Reserves, and wildlife clubs. Many local people have a real desire to learn about their

environment and its wildlife; for example, I am always amazed and heartened by the interest shown in my research by school children, local villagers, game rangers and many others. Questions such as 'How do you know the name of this mammal?', 'Where does it live?', and 'Can you give me a book about these mammals?' emphasise the difficulties of obtaining information when there are no books or other means of learning. It is important that researchers direct some of their energy and time to educating the people who will 'make or break' effective conservation, as well as producing erudite papers in scientific journals.

Education

Knowledge engenders appreciation, and is an incentive to learn more. Many rural people have never had the opportunity to obtain a basic education and therefore find it difficult to comprehend the ecological value of their environment or to foresee the effects of mismanagement. Basic education at the level of the three 'R's is an essential step to knowledge and a better life. If rural communities understand their wildlife communities, and benefit directly from them, they are more likely to treasure them as a useful resource. In addition, education (especially of women) is correlated with a decrease in fecundity and therefore a lower annual rate of population increase. Education and knowledge will act in many ways to reduce human conflict and competition with mammals.

In many African countries, education about resources, environment and wildlife is more freely available now than a few years ago. More young people are going to school, and there are extension courses and wildlife clubs. Access and accommodation to reserved areas is becoming increasingly easy for local people.

Conclusion

Human numbers, agriculture, deforestation and other human activities have increased dramatically in the last 40 years, and have resulted in a large reduction in the numbers and geographical ranges of many species of mammals. The suggestions listed above have the potential to increase the chances of successful conservation. They must be encouraged, wisely funded, and carefully modified to fit the conditions of each region and community. Erudite studies by visiting scientists may provide interesting advances in science, but are unlikely to help conserve the mammals which have provided these advances. Conservation of African mammals must start at the level of the 'grass roots'; and it must begin by promoting a harmonious relationship between humans and mammals because this is the only way that successful conservation can be accomplished.

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