State of Biodiversity: Western Cape Province, South Africa Mammals

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Introduction

The Western Cape Province (W.C.P.) of South Africa, one of nine provinces forming the country, is generally regarded in South African terms as being "poor" with respect to the number of its mammals when compared to the other eight provinces. This misconception has its origin in the fact that the Western Cape, essentially a winter rainfall region, lies adjacent to one of the richest spots in the world in terms of mammalian diversity, namely the summer rainfall region of the rest of South Africa. In fact only when compared with the rest of our own country can the Western Cape be regarded as having a "poor" mammofauna in terms of biodiversity. However, some of the other Western Cape vertebrate and many of the invertebrate groups do reflect higher levels of biodiversity, as do the plants; and almost all groups show higher levels of endemism. The misconception regarding mammalian diversity in the Western Cape is partially exacerbated by the relatively low biomass mainly due to the low nutrient status which is fairly characteristic of the fynbos biome.

The historic distribution of the larger mammals within the W.C.P. is probably better documented than that of any other faunal group in South Africa (see Skead, 1980; Skead, 1987; and Rookmaker, 1989) and the role that mammals played in the development of nature conservation in the W.C.P. is well summarized by Hey (1977).

Methods

The relevant literature was consulted to assemble a list of those mammalian species and other taxa that have been recorded from within the present boundaries of the Western Cape Province, which are also known to live under relatively natural conditions, and to exclude those species/taxa which are only known to survive under purely captive conditions such as those prevailing in zoological gardens and similar institutions or those maintained as pets or for purposes of the pet trade.

Two of the most important references used were "Classification of Southern African Mammals" (Meester, Rautenbach, Dippenaar and Baker, 1986) and "The Mammals of the Southern African Subregion (New Edition)" (Skinner and Smithers, 1990). The taxa listed in these two references (with minor modifications to accommodate the latest available information, particularly in the minor instances where these two references differed) were entered into the biodiversity database, incorporating all the known species and subspecies indicated. In the case of the latter it was Meester, *et al.* (1986) which was most heavily relied upon. The result of this exercise was a list of all the mammals known to occur within the southern African subregion (a region defined loosely as that south of a line joining the Kunene and Zambesi Rivers), at currently recognized (warts and all!) subspecific level. For reference purposes typical subspecies (*i.e.* those subspecies whose trinomial is the same as the specific epithet; in other words where the species and subspecies names are the same) were included even if that typical subspecies did not occur within the subregion. For the purposes of this paper, with minor exceptions, only species are discussed.

The next step was to identify from W.C.N.C.B. records, museum records and literature records of the current and historic (recorded recent history) distribution of mammals, those taxa known to occur or to have recently occurred in what is now politically defined as the Western Cape Province. The precision of locality-recording encompasses the full spectrum, from very coarse, to point localities determined to the nearest second in terms of longitude and latitude.

The following step was to identify those taxa that were known to be restricted to this geographic region and those nearly restricted to it, in other words those taxa endemic or nearly endemic to the W.C.P. Because of the relatively unique character of the W.C.P. which encompasses the majority of the Cape Floristic Kingdom (C.F.K.), similar statistics for this region were also identified.

The subsequent step was to identify those mammalian taxa (both from our own records and the published literature) which are considered to be at some level of risk in terms of continued survival, which has culminated in the publication of local and international lists of threatened mammalian taxa (*e.g.* various IUCN Red Lists and various South African Red Data Books), and other categories for purposes of protection, as has also been undertaken for other vertebrate and invertebrate groupings. These threats/risks are well summarized in a variety of publications (see particularly Skinner, Fairall and Bothma, 1977; and Smithers, 1986), as are many of the critical habitats. These are supplemented by W.C.N.C.B. records.

Mammalogical Statistics

Of the approximately (due to taxonomic vagaries and continuing developments in molecular genetic techniques) 340 naturally-occurring species of mammal known from the southern African subregion, ±280 species are recorded for South Africa (*i.e.* 82% of mammals occurring in the Southern African Subregion are also to be found in South Africa) (Meester *et al.*, 1986). For the W.C.P., the number

of naturally-occurring mammalian species recorded is considerably lower at 160 (*i.e.* only 57% of the species occurring in South Africa, also occur in the W.C.P.), hence the commonly heard statement that this province is impoverished with respect to mammals.

To place the mammalian riches of the Western Cape into proper perspective and context it is, therefore, instructive to compare the province to the whole of Western Europe, which is roughly an order of magnitude larger. Both Western Europe and the Western Cape, despite the difference in area, can claim to have been home to ±160 species of mammal in recent history. These range in size from tiny shrews to the largest of whales in both regions. However, whereas species of only nine of the 18 or 19 living mammalian Orders (depending on which references are used; *e.g.* Miller and Levine (1991) recognizing 18 and Orr (1966) recognizing 19) can be encountered in Western Europe (Chinery, 1993), the Western Cape alone has species from 13 or 14 of the 18 or 19 mammalian Orders (again depending on which references are used) still surviving, and this in an area one tenth the size.

Although a small number (probably only 11) of the species in the Western Cape became locally extinct, a large proportion of these locally extinct species have now been re-established. Only one or two species, depending on which references are used, in the Western Cape have become completely extinct. These are the blue antelope, *Hippotragus leucophaeus*, and the quagga, *Equus quagga*; the latter, however, is considered by most modern taxonomists as the southernmost subspecies of the plains zebra, *Equus burchelli*. Similarly the so-called "Cape lion" is simply considered to represent the southernmost ecotype of the lion, *Panthera leo*.

To these 160 species in the Western Cape, can probably be added a further 15 or more species which are not native to the Western Cape (including species both alien to the RSA; and indigenous to the RSA, but not indigenous to the W.C.P.) but which, unfortunately, can be regarded as having become established, to a lesser or greater extent, in the wild. For Western Europe this figure is 23 or more such species. In the W.C.P. this number could potentially increase due to pressure from the game industry to be allowed to bring into the W.C.P. even more species which never occurred here naturally.

Although not in quite the same proportion as the rest of South Africa, the Western Cape also has mammals which are endemic to its boundaries. Six mammal species (<4%) are known to be endemic to both the C.F.K. and the W.C.P. (see Table 1), but many more subspecies are also unique to these regions. A further two mammalian species are known to be endemic to the C.F.K., and near-endemic to the W.C.P. (*Chlorotalpa duthiae* and *Myomyscus verreauxi*), and a further four species are also known to be near-endemic to the province (*Aethomys granti*, *Chrysochloris asiatica*, *Myotis lesueuri*, and *Raphicerus melanotis*). A further 13 species endemic to the country as a whole also occur within the province, meaning that 25 of the species endemic to South Africa are (or were) also Western Cape species (as mentioned earlier at least one of these species is now completely extinct). Of those mammals that became extinct within the boundaries of the province, but which survived elsewhere, only six have yet to be re-established within the province in a truly wild state on formally conserved State land. These are represented by the lion (*Panthera leo)*, the spotted hyaena (*Crocuta crocuta*), African wild dog (*Lycaon pictus*), the black rhinoceros (*Diceros bicornis)*, the hippopotamus (*Hippopotamus amphibius*), and the Cape or African buffalo (*Syncerus caffer*). All of these species are under consideration for reintroduction to suitable areas provided funding for appropriate boundary fencing, or in some cases reserve expansion, can be obtained, for those species where this is necessary. Two of these species are widely expected to have occurred within the province but few or no material records currently appear to exist; these are the African wild dog and the spotted hyaena. Evidence to corroborate their existence or previous occurrence within the province is regarded as a natural history research priority. Similarly, whether or not the riverine rabbit still exists (or ever did) within the boundaries of the Western Cape Province, is part of the subject of a current research project. At present it is generally regarded as part of the Western Cape fauna, as are the two former. Species existing on conserved Western Cape areas in what are

Table 1. Mammalian species which are endemic or near-endemic to the W.C.P.

Species	W.C.P. endemic	C.F.K. endemic	W.C.P. near-endemic
Acomys subspinosus	√	√	
Bathyergus suillus	√	√	
Cryptochloris zyli	√	√	
Hippotragus leucophaeus	√	√	
Myosorex longicaudatus	√	√	
Tatera afra	√	√	
Chlorotalpa duthiae		√	√
Myomyscus verreauxi		√	√
Aethomys granti			√
Chrysochloris asiatica			√
Myotis lesueuri			√
Raphicerus melanotis			√

currently considered to be non-viable numbers include the cheetah, the brown hyaena, and the African elephant.

Two antelope species which became extinct throughout the province but survived elsewhere, have been successfully re-established, namely the eland and the red hartebeest. Several other species which died out in parts of the province have been successfully re-established in several areas from surviving populations elsewhere within the province; these include springbok, bontebok, and Cape mountain zebra. Several areas still exist where further re-establishment of these species can be considered.

Considerable success has been achieved in the conservation efforts aimed at protecting the mammals of the Western Cape, as is evidenced by the fact that several mammals have been accorded improved conservation status by being listed in lower categories of threat in more recent Red Data Books and Red Lists compared with earlier editions. However, many of these mammals, despite being well-represented in many provincial nature reserves and National Parks, are still considered to be under some form of threat (whether this be because their numbers are still below certain threshholds, or because their natural habitat outside conservation areas is extremely limited or degraded). As a result, if we examine those species that are unequivocally still known to occur; those species that are thought probably to occur (without material evidence as yet of their presence); those species that occurred historically and have not yet been reintroduced; and those species which probably occurred historically (but for which unequivocal evidence is currently lacking), we find ourselves looking at a wide range of categories of threat or protection.

The "1994 IUCN Red List" (published in 1993 (Groombridge, 1993)) lists thirty (30) Western Cape species as "Insufficiently Known (K)"; two (2) Western Cape species as "Indeterminate (I)" (implying that they are either rare, vulnerable or endangered but insufficient information exists as to which is the most appropriate); four (4) Western Cape species as "Rare (R)"; seven (7) Western Cape species as "Vulnerable (V)"; six (6) Western Cape species as "Endangered (E)"; and one (1) Western Cape species as "Extinct (EX)" (*i.e.* a total of 50 Western Cape mammalian species in the Red List).

The "South African Red Data Book – Terrestrial Mammals" (Smithers, 1986), by way of comparison, lists two (2) Western Cape species as "Out of Danger (OOD)"; fourteen (14) Western Cape species as "Indeterminate (I)"; eleven (11) Western Cape species as "Rare (R)"; five (5) Western Cape species as "Vulnerable (V)"; two (2) Western Cape species as "Edangered (E)"; and one (1) Western Cape species as "Extinct" (*i.e.* a total of 35 Western Cape mammalian species in the S.A. Red Data Book).

In terms of the "Convention on International Trade in Endangered Species of Fauna and Flora (CITES)", twelve (12) Western Cape species are listed in Appendix I and a further twelve (12) species in Appendix II.

In terms of published IUCN status reports using the recently proposed and revised IUCN threat categories at the time of preparing this report, the only one available to W.C.N.C.B. for mammals was that of East (1999) for antelope. In this report four (4) antelope species occurring naturally in the Western Cape are listed as "Lower Risk (least concern)"; and ten (10) antelope species as "Lower Risk (conservation dependent)". A single (1) antelope subspecies, namely *Damaliscus dorcas dorcas* (the bontebok), is listed as "Vulnerable".

In terms of the Nature Conservation Ordinance of the Western Cape Province (Ordinance No. 19 of 1974; and also still applicable to the Northern Cape Province and the Eastern Cape Province) two categories of special protection are offered to wild animals. Schedule 1 is a list of animals considered to be "Endangered Wild Animals" and Schedule 2 is a list of animals declared to be "Protected Wild Animals". Accounting only for listed species known to occur within the Western Cape Province (and excluding those known from the Northern and Eastern Cape and not known from the Western Cape) 71 species of mammal are considered to be "Protected Wild Animals" in the Western Cape and a further three species are considered to be "Endangered Wild Animals", namely *Acinonyx jubatus* (the cheetah), *Diceros bicornis* (the black rhinoceros), and *Bunolagus monticularis* (the riverine rabbit) plus one subspecies, namely *Equus zebra zebra* (the Cape mountain zebra). This ordinance has recently been amended for the Western Cape Province and is now known as "The Western Cape Nature Conservation Laws Amendment Act, 2000" (Provincial Gazette Extraordinary, 5426 of 17 February 2000).

For the purposes of this document the details for subspecific categories will not be included although they will be available from the database (but not at the same level of accuracy as for species, particularly because of the dynamic nature of taxonomy at this level). However, two exceptions, the bontebok (*Damaliscus dorcas dorcas*) and the Cape mountain zebra (*Equus zebra zebra*), based on the fact that the subspecies in question differ morphologically from their related subspecies to the extent that they have different, colloquially derived, common names, and the fact that both these subspecies have considerable economic value, would seem to be sufficiently important for their inclusion in this report. The statistics for these two subspecies are provided in Table 2.

Table 2. The endemic and conservation status, and legal protection for the Cape mountain zebra and bontebok in the W.C.P.

Scientific Name	Common Name	Endemic to	IUCN	SARDB	CITES	Prop. IUCN	Ordinance
Equus zebra zebra	Cape mountain zebra	Former Cape Prov.	E	Vulnerable	AI	VU	S1
Damaliscus dorcas dorcas	Bontebok	Western Cape Prov.	R	Rare	AII	VU	S2

Data quality

The quality of the data in terms of taxonomic currency at the time of writing reflects the most recent interpretation, including recent genetic evaluations based on modern molecular biological techniques. In terms of the quality of the locality data, these records vary extensively, as previously alluded to, from relatively vague literature records referring to general districts, via discrete quarter degree squares ($1/16^{th}$ degree squares), down to point localities determined in various ways, including geographic positioning system technology.

In terms of the larger to medium-sized mammals, which for the most part are highly mobile, this does not represent much of a problem. However, with the smaller mammals, even in the case of the bats (Order Chiroptera), it is considerably more meaningful to have locality data of greater precision in order to understand their habitat requirements more accurately. For example several of the fossorial small mammals such as the golden moles, or chrysochlorids (Order Insectivora; family Chrysochloridae) and the rodent moles, or mole-rats, or bathyergids (Order Rodentia; family Bathyergidae) are likely to display preferences for specific soil-types; similarly detailed knowledge of different cave-systems could provide clues as to why certain caves are preferentially used by certain species of bats in contrast with other caves utilized by different species of bats.

Unfortunately, in terms of spatial analysis, the data are mostly available at the quarter degree square (QDS) level which is generally not fine enough to allow for ecological interpretation. Furthermore temporal analysis is hampered by crudely recorded dates and times, or the complete lack of temporal information. For those records where point localities (to the nearest second with respect to latitude and longitude) are available, the associated temporal data are usually reliable, but the current number of such records is far too small to allow for meaningful analysis. Precise data for such records therefore remain a priority.

Critical Habitats

If one were to look at a broad category of habitats that are critical for the survival of a large number of mammal species, the first that would come to mind is that of the marine environment. This is an over-simplification, however, since, despite the fact that almost 40 species of mammals (almost 25%) of the Western Cape Province are dependent (or occasionally so) on the coastal waters of the province, they actually represent a group of mammals utilizing, or dependent on, a wide variety of habitats, which in a world of greater exposure to terrestrial habitats tend to be regarded as a single uniform environment. The marine environment is probably as diverse as the terrestrial environment, but because of its lesser exposure to human society, this environment tends to be viewed as one so-called "habitat", whereas in fact it represents many environments. The most critical of these, however, is probably the inshore marine environment directly adjacent to the shore.

A closer examination, therefore, of critical habitats in the W.C.P. in terms of mammals, more or less suggests a tie between mammals associated with the renosterveld lowlands (and particularly the grazing available within them) and mammals associated with rivers (and particularly the associated riparian vegetation) and wetlands. Although both these habitats (lowland and water-associated) are utilized by a wide range of mammalian species, approximately 20 species are (or would be) effectively dependent to a lesser or greater extent on the continued availability of each of these habitats in the Western Cape for their continued survival (or the maintenance of these habitats, for those species which could be re-established).

In the case of the lowland renosterveld, at least five grazing ungulate species were previously dependent on this habitat for their survival within the W.C.P. or the C.F.K.; namely the (extinct) quagga (now considered to be the southernmost subspecies of the plains zebra); the African buffalo (in a small part of the southern lowland renosterveld); the extinct blue antelope; the bontebok (also only in the southern lowland renosterveld); and the red hartebeest which occurred throughout the C.F.K. (probably represented by what is now considered to be an extinct subspecies). The re-establishment, or continued survival of those ungulate taxa which are still extant within their natural habitat, within the C.F.K. depends to a great extent on the conservation of the remaining portions of this extremely threatened and fragmented habitat and to some extent on the success or failure of potential ecological restoration techniques. The presence of these five grazing ungulates in the C.F.K. was thus effectively only possible because of the presence of grass within the lowland renosterveld, which, prior to being ploughed for cultivation, must have come closest to resembling a grassland/savannah habitat within the greater shrub-dominated C.F.K., thereby accommodating species more typical of grassland and savannah habitats elsewhere.

Another large mammal which previously also occupied the lowland renosterveld, amongst other habitats, in the C.F.K. and the W.C.P., was the black rhinoceros, but it could also survive in other habitats. However, this habitat was not only important for larger mammals. The sandier portions of the lowland renosterveld represent important habitats for W.C.P. and C.F.K. endemic species such as the Cape gerbil (*Tatera afra*); the Cape dune molerat (*Bathyergus suillus*); and Van Zyl's golden mole (*Cryptochloris zyli*).

The current state of fragmentation of these remaining lowland habitats and their potential importance in conserving several "charismatic" mammalian species, should, therefore, be seen as a major factor in support of a variety of proposed ecological restoration programmes.

In the case of the riverine habitats and wetlands, there are also at least four species wholly dependent on the good health of these environments in the W.C.P. (and the C.F.K.). The wholly dependent species are the Cape clawless otter (*Aonyx capensis*); the water mongoose (*Atilax paludinosus*); the water rat (*Dasymus incomtus*); and the hippopotamus (*Hippopotamus amphibius*). A fifth species, the riverine rabbit (*Bunolagus monticularis*) is dependent on the alluvial floodplains of a restricted number of non-perennial rivers in the western Karoo for its survival. However, the role of riverine and wetland habitats in extending the range of certain species,

particularly typically forest-adapted species; in acting as corridors between different areas of their preferred or more sustainable habitats; or simply in making the environment considerably more attractive for some species (without knowing the degree of dependency); cannot be underestimated. In the latter case species such as the large-spotted genet (*Genetta tigrina*); the large grey (or Egyptian) mongoose (*Herpestes ichneumon*); the serval (*Felis serval*); the reddish-grey musk shrew (*Crocidura cyanea*); the greater musk shrew (*Crocidura flavescens*); Brant's climbing mouse (*Dendromus mesomelas*); the vlei rat (*Otomys irroratus*); Verreaux's mouse (*Myomyscus verreauxi*); woodland dormouse (*Graphiurus murinus*); and Cape molerat or "blesmol" (*Georychus capensis*) are probably implicated. Species which utilise rivers as extensions of their more typical forest or woodland/savannah habitats, or as corridors between areas of preferred habitat (or both), historically included species such as black rhinoceros (*Diceros bicornis*); elephant (*Loxodonta africana*); African buffalo (*Syncerus caffer*); but still also include animals such as vervet monkey (*Cercopithecus aethiops*); kudu (*Tragelaphus strepsiceros*); leopard (*Panthera pardus*); the lesser woolly bat (*Kerivoula lanosa*) (which may be restricted to riverine habitats); Wahlberg's epauletted fruit bat (*Epomophorus wahlbergi*), which uses riverine forest vegetation as an extension of its true forest habitat; and probably the Namib long-eared bat (*Laephotis namibensis*). Many other species probably also benefit from these aquatic habitats and links.

Another critical habitat for a fairly specialized group of mammals, and for many other vertebrates too, but particularly for a wide range of invertebrates, particularly for some of the rarer species in the W.C.P., is the speleological (or cave) environment. In terms of mammals the most important inhabitants of caves (and frequently man-made equivalent excavations) are obviously bats (the Order Chiroptera). Not all insectivorous bats are obligate cave-dwellers, although of the 16 insectivorous and three frugivorous bats recorded from the W.C.P., all but four are known to utilize caves at least some of the time. Of the four bat species known not to utilize caves, two are fruit bats. Of the 14 insectivorous species of bats utilizing caves, six to the best of our knowledge are obligate cave-dwellers. Only one species of fruit bat, namely the Egyptian fruit bat (*Rousettus aegyptiacus*), is closely associated with caves, to the extent that it can effectively also be regarded as an obligate cave-dweller, at least at certain times of the year.

These critically important habitats are generally considered to be in a relatively healthy condition, except for certain caves in close proximity to the larger urban environments. In these disturbed/damaged/transformed caves past losses in the numbers of certain colonial species could have been considerable.

Another habitat under considerable threat, mostly due to residential and recreational development, is that which includes the coastal dunes and their associated sandy areas. By its very nature this environment, at least in patches, is particularly dynamic, even in some of the secondary and tertiary dune thickets. Because of this dynamic nature it is perhaps not surprising that it is not the richest habitat in terms of mammalian biodiversity, yet certain species appear to have become more or less adapted to it. One of the species in this category appears to be Grant's golden mole (*Eremitalpa granti*) on the western coast of the province, whereas another appears to be the Zulu golden mole (*Amblysomus iris*) on the sandy areas of the southern coast of the province. Other species which are frequent inhabitants of this habitat, and other sandy areas, are the Cape dune molerat (*Bathyergus suillus*); the Cape molerat (*Georychus capensis*); and the Cape golden mole (*Chrysochloris asiatica*). Another species which utilizes associated sandy areas, but not the dune areas necessarily, is the Cape gerbil (*Tatera afra*).

Species which utilize the dune vegetation, particularly in areas adjacent or close to coastal forest, are animals such as the blue duiker (*Philantomba monticola*), the bushbuck (*Tragelaphus scriptus*), and the bushpig (*Potamochoerus porcus*), even if these are not necessarily their most preferred habitats. Species which utilize this environment as corridors to areas of more preferred habitat are numerous, but include species such as the leopard (*Panthera pardus*).

Afromontane and coastal forest habitats are naturally fragmented in the W.C.P. but this fragmentation has been exacerbated by considerable utilization in the past. Although the W.C.P. forest environments do not exhibit high levels of mammalian biodiversity (in contrast with many forest habitats elsewhere in the country) there are a few mammalian species and subspecies which are nearly endemic to these forests. The blue duiker (*Philantomba monticola*) and the bushpig (*Potamochoerus porcus*) are species whose major strongholds are within the forests but both species are also found in adjacent thicket or coastal scrub environments. The effects of forest fragmentation on mammalian diversity should therefore be monitored and where possible consolidation should be considered.

Lowland fynbos, whilst also representing a habitat enormously reduced from its original extent, is again a habitat exhibiting low levels of mammalian biodiversity, probably attributable to the low nutrient levels in the soils and the highly unpalateable character of the leaves of most fynbos plants. The reintroduction of the bulk megaherbivores into such habitats could potentially increase their productivity due to nutrient recycling, particularly in terms of making nitrogen-associated nutrients more accessible, and also through their mere presence by producing pathways through otherwise potentially homogeneous stands of fynbos shrubs permitting the development of grass along these paths, which could also play a role in creating more of a vegetation mosaic with respect to age and species composition as a result of acting as minor firebreaks.

The marine environments, particularly inshore, are subject to enormous utilization pressures at present, particularly aimed at coastal fish species, rock lobster and abalone, but with several other species being targeted with lower intensities (including species such as the great white shark). The marine mammal component, however, currently appears to be facing fewer threats than ever before. However, if the pelagic fish stocks were to suffer a major decline, a large number of marine mammals could suffer considerable negative impacts.

The Karooid environments, many of which have been severely modified/transformed due to unsound agricultural practices, are fortunately extensive. As a result many mammal species have been able to persist in viable numbers and with the current interest in the game industry, many species, but most notably the springbok (*Antidorcas marsupialis*), now probably occur in much larger numbers than, say, 30 years ago. Apart from the Karooid river systems alluded to earlier, most mammals in the karoo are still relatively secure.

Because of its extent and protection from development, the least threatened habitat in the W.C.P. is montane fynbos. Despite exhibiting relatively low levels of mammalian biodiversity, for example in comparison with the Karoo, it nevertheless provides valuable sanctuary to a wide range of mammals. These include animals as diverse as rock dassies (*Procavia capensis*) and baboons (*Papio ursinus*), which could be regarded as keystone species, and "top" carnivores such as leopards (*Panthera pardus*), brown hyenas (*Hyaena brunnea*), honey badgers (*Mellivora capensis*).

Threats to Mammalian Biodiversity

Undoubtedly the greatest threat to mammalian biodiversity and indeed biodiversity in general is the continuing loss or irreversible transformation of natural habitat due to agricultural and industrial development, mining, urbanization, and the spread of alien biota. This loss of natural habitat, and the associated fragmentation of what is left, is exacerbated in the case of those specialist mammals with very specific habitat preferences such as the riverine rabbit (Karooid riverine systems), and bontebok (grasslands within the renosterveld). The associated losses in the availability of food, cover, and shelter, combined with the problems caused by declining numbers is thus a real problem for several species, particularly for those which are naturally rare or those which now have restricted distributions as a result of anthropogenic forces.

Another more insidious threat, however, is that of a variety of threats to genetic integrity, particularly in the case of taxa involved in the game industry. Because of the economic value of these traditional "game species" several concessions have been made with respect to some of those species being conditionally permitted to be maintained on properties outside their natural ranges under what are effectively "wild" conditions (see "Policy on the importation and translocation of mammals into and within the Cape Province", Lloyd and Lensing (1990)). Apart from the more obvious genetic implications of hybridization between subspecies (*e.g.* between blesbok (*Damaliscus dorcas phillipsi*) and bontebok (*Damaliscus dorcas dorcas*)), relatively recent developments have indicated that so-called "good" species (as opposed to subspecies) are frequently so genetically similar that compatability between them is of such a nature that interspecific hybridization can lead to the production of fertile hybrids. Classical examples which have been well-documented are those of fertile interspecific hybrids between various species in the genus *Kobus* (which includes the waterbuck, lechwe, kob and puku (Gray, 1972)) and those of the genus *Connochaetes* (with several populations of fertile hybrids between black and blue wildebeest having been recorded recently, including in the scientific literature (Fabricius, van Hensbergen and Zucchini, 1989)).

Another potential threat to mammalian biodiversity is the threat of pathogenic impacts, due to the movement of taxa important to the game industry. The variety of diseases that could be introduced into new areas is potentially large and in the cases of viral, or similar, diseases, in particular, could in some cases have devastating effects, because of the difficulty in both detecting and treating them. This includes diseases which can be transmitted from both wild and domestic mammals (*e.g.* bovine tuberculosis).

A less likely threat, but nevertheless possible, is the ecological effect an introduced taxon could have on a locally resident taxon through competition and partial or complete displacement. This includes the introduction of wild species not indigenous to South Africa into new environments (*e.g.* the Himalayan tahr, *Hemitragus jemlahicus*, on Table Mountain), and the introduction of species indigenous to South Africa into South African and W.C.P. environments which are not part of their natural distribution range (*e.g.* impala, *Aepyceros melampus*, in the southern Cape). The threat is not limited to "alien" animals alone, but includes the threats posed by invasive "alien" vegetation.

The last three threats listed are all impacts caused by the introduction of inappropriate taxa alien to the area of introduction. This serves to illustrate the need for at least a national mammalian translocation policy and preferably one covering all biota. Other threats to mammals include issues such as illegal hunting leading to over-exploitation. Apart from traditional poaching, the bushmeat industry, which has rapidly expanded elsewhere in Africa, is now underway in South Africa as well. A further threat is the persecution of those taxa which opportunistically utilize crops and domestic livestock. Yet another threat is the reintroduction of species into areas which are not sufficiently large to support genetically viable numbers of the species in question.

Chemical and physical pollution of the environment is also an important threat to wildlife in the urbanized terrestrial areas and associated coastal developments. Apart from nuclear waste, the worst and most persistent pollutants are probably those derived from the petrochemical industry. Although not necessarily the most toxic of substances, the pollutants from this industry are transported throughout the planet; over the oceans and across continents. Some of the most insidious pollutants, however, many also derived from the petrochemical industry, are the agrochemicals used as herbicides, pesticides, growth stimulants, reproductive stimulants and inhibitors, *etc.*, which can result in either increased toxicity or increased nutrient status (eutrophication) within local and sometimes distant environments. Other pollutants which can have dire consequences for animals are the artificial sexual hormones used in human society, which mimic their natural equivalents, but often end up in wetland environments and become absorbed by wild animals with varying results. Marine pollution, generally viewed mostly in terms of marine birdlife, can be equally devastating to other forms of wildlife, including mammals

and with the importance of the oceanic trade routes around the tip of Africa, remains a major threat.

Current declining funding for nature conservation poses a further threat to mammalian conservation because of the associated reduction in manpower to advise on conservation problems and to enforce conservation legislation.

Effectiveness of Current Conservation

Although difficult to evaluate because of the limited distributional data, particularly for smaller mammals, and the complications caused by the artificial movement (or translocation) of certain taxa amongst the larger mammals because of the "game" industry, the efficacy of conservation efforts is most dramatically apparent in terms of the success, in numeric terms, of the conservation of many of the ungulates previously considered to be under considerable threat *e.g.* registered pure bontebok numbers now exceed 2 500, and Cape mountain zebras now exceed 1 000 in number.

However, the majority of the conservation areas are inadequate in terms of conserving viable numbers of some of the larger and medium-sized carnivores and more particularly the megaherbivores. Similarly, species with linear distributions along water-courses, particularly the riverine rabbit, are either not conserved at all in formal conservation areas, or are relatively poorly conserved. This also applies to several other mammal species associated with wetlands in general, and river systems in particular, such as otters. This means that for many taxa their conservation still depends to a great extent on the private landowner.

However, in terms of many of the smaller mammals, the fact that many of their larger relatives are adequately conserved numerically and in a sufficient variety of habitats (for those taxa which are not so specialized as to require only one sort of habitat), means that many of these smaller mammals' habitats, frequently consisting of a variety of microhabitats and "microecotones" are fortuitously also conserved. Only those highly specialized habitat specialists, such as the riverine rabbit, are generally, or often, excluded from such conservation measures. Habitat specialists, amongst the smaller mammals, therefore, such as the riverine rabbit, bats in general, especially the cave-dwelling insectivorous taxa, and other specialized taxa, are the targets on which small-mammal conservation efforts should be focused. Similarly, larger mammals with specialized requirements threatened by agriculture and other developments, also represent species to be targeted for further conservation action; *e.g.* hippopotamus.

In summary, the effectiveness of the formally conserved areas in conserving biodiversity is therefore quite considerable for certain taxa, and many of these taxa (particularly traditional game species) are also preserved by private landowners, albeit without many of the selective pressures which they should be exposed to, but there are several taxa for which current formal conserved areas provide little or no conservation value, and it is these taxa that should be the highest priority for conservation action, especially through land purchases; consolidation; expansion; joining and linking of existing conservation areas; and whatever other means that are available. The Cape Action for People and the Environment (C.A.P.E.) will hopefully address some of these issues and is discussed more fully in the section dealing with recommendations.

Apart from the physical conservation effort in the form of protecting appropriate habitat, there are also the legislative and administrative aspects of wildlife conservation. The legislative aspect starts with international conventions to which South Africa is a signatory, some of which have already been incorporated into South African Law. This is followed by national legislation, with a variety of Acts having an impact and effect on mammalian and other wildlife. Each of the nine provinces, presently with concurrent responsibility for nature conservation, has its own (or shared) provincial legislation dealing with issues within its boundaries. Finally local authorities frequently also have bye-laws and regulations. In some instances there are legislative differences between the provinces, and between the provinces and local authorities, which hamper informed decision-making and illustrate the need for more uniformity among the provinces.

Although much of the necessary legislation is in place, some of it is outdated. Furthermore, as alluded to above, there are cases where international conventions have been signed but not yet been ratified because they have not yet been incorporated into national legislation. Similarly certain proposed national legislation has still not been finalized, and this is also partially true of some of the provinces where new ordinances or provincial acts have been proposed but with little progress. Slow progress is being made but this inertia is currently symptomatic of conservation throughout the country which in general suffers from a lack of financial and human resources. This is particularly noticeable with respect to the shortcomings concerning structured monitoring programmes.

Utilization of Mammalian Diversity

The utilization of terrestrial mammals persists as probably the major economically important form of vertebrate utilization with both domestic and wild animals. Whilst in the case of the latter this is also a valid and justifiable economic pursuit, it is not without its environmental risks. Many concessions have been made to the game industry from the conservation authorities' points of view, in order to accommodate this highly-profitable economic activity. These concessions include the right to maintain certain species outside their natural distribution ranges (this includes certain non-indigenous ("alien") taxa (*e.g.* fallow deer, *Cervus dama* and Indian blackbuck, *Antilope cervicapra*) and certain taxa indigenous to the RSA, but outside their natural range) provided that certain minimal conditions are met. Utilization, however, does pose a real and potential threat to biodiversity when this activity or economic pursuit involves the large-scale uncontrolled movement of organisms, and these threats include ecological damage caused by an escaped "alien" organism which has the potential to flourish in its new environment; they include the introduction of pathogens occurring naturally in the animal introduced to the new area, but which are pathogens not previously present in the new environment or on its biota; they include potential

hybridization problems in the cases of a close genetic relationship where a taxon from elsewhere is introduced into an area to which its close relation is endemic, with resultant hybridization producing organisms less well-adapted to either environment; and they include the removal of naturally selective pressures which could have negative effects on their continued evolution.

The game industry effectively has four facets; namely the production of meat; the breeding of rare taxa for profit; the provision of hunting opportunities; and the provision of opportunities for ecotourists to observe wildlife, particularly the larger and rarer species. Each of these facets, unless carefully managed, can result in compromising the ecological, pathogenic and genetic health of other taxa. Associated with the hunting industry are a number of ancillary industries such as the trophy registration industry, the taxidermy industry, parts of the fire-arm industry and the meat/venison industry.

There is, however, another form of mammalian wildlife utilization and that is the requirement by the medical profession for animals on which to undertake humane experimentation. This industry is mostly but not entirely restricted to the utilization of primates, mostly in the form of baboons and vervet monkeys. Harvesting of animals in the wild, however, is now restricted to those animals which can be shown to have caused agricultural damage, and is controlled by a permit system.

In both the above cases (*i.e.* the game industry and the needs of the medical profession) the owner of the property on which these animals occur (game or problem animals) benefits financially, to a greater or lesser extent, through this utilization. Furthermore, in both cases the utilization is maintained at sustainable levels; in the game industry standard animal husbandry practices are largely followed (*i.e.* "living off the interest and preserving the capital") and the small demand by the medical profession also ensures sustainability in the latter case.

There is also a small demand for certain species from the wild by zoological gardens either for research or display, and this is catered for by recognized (soon to be registered) animal dealers. Similarly there is also a small demand for certain wild mammals for research purposes, usually aimed at providing biological information which will be useful for further conservation purposes.

Another form of the utilization of wild animals forms part of the pet trade, whereby certain species representing wild animals which have been bred in captivity are regarded as "recognized pet species" and are exempt from most legislation (*e.g.* squirrel monkeys, *Saimiri sciureus*). Utilization of indigenous species for this trade is discouraged.

Economic Incentives to Conserve Mammals

The economic incentives to conserve certain species of mammals are relatively simple; very high economic returns can be obtained through live sales and trophy-hunting (particularly of the rarer megaherbivores, the larger carnivores, and the rarer traditional game species) and through various ecotourism activities. The game industry, for a variety of reasons, places a particularly high monetary value on taxa which have a particular appeal to certain segments of human society. These include firstly the megaherbivores (*e.g.* >R500 000 for a black rhinoceros; >R100 000 for a buffalo), which because of their rapid numerical declines elsewhere on the continent generate a keen interest from conservation-conscious members of society, often far in excess of their apparent rarity (*e.g.* apart from an interest by specialist collectors, the many even rarer invertebrates attract relatively little interest, other than as dead specimens of a rare "commodity"), and also, to a lesser extent, from the hunting fraternity as potential hunting trophies. Some of the larger carnivores, unfortunately for them, in many areas of private land *only* have appeal as potential hunting trophies, but in the Western Cape there is a greater emphasis on their being used as drawcards for ecotourism. This is probably true throughout South Africa for the lion, for example, but less so for even the leopard, whereas sadly the hyenas and African wild dogs have relatively little general appeal, except for the wealthy tourists. The traditional game species, typically the rarer large antelopes, generate appeal both in terms of aesthetic qualities and hunting.

Generally speaking in terms of the so-called "game industry", therefore, sufficient financial incentives already exist, provided that the provisioners of these income-generating activities have sufficient capital to make the original investment in acquiring these taxa. This presents several problems since because of this limiting factor, many landowners wish to acquire the most sought-after or most readily available taxa, whether they occur naturally (or occurred historically) in the region in which their properties occur or not. This in turn, as mentioned above, raises several other problems in terms of potential ecological, pathogenic, and genetic threats to naturally occurring taxa. Even when these landowners do purchase the appropriate taxa, they often cannot purchase sufficient animals in terms of long-term genetic considerations.

It is our opinion that there are several opportunities to provide a variety of incentives to landowners to maintain appropriate taxa and land-use practices if certain guidelines are followed. It should be borne in mind that private landowners with pristine undeveloped land, *i.e.* land in a natural or unploughed state with little or no alien vegetation, represent a very important group of custodians of biodiversity and if they were to transform this land through ploughing it up or overutilizing it with livestock, biodiversity losses could be enormous, particularly in the W.C.P. lowlands. This fact should be factored into the revenue system by taking into account the value of such property in protecting elements of biodiversity, which are in effect and fact (in terms of the Convention on Biological Diversity) State assets, and implemented as some form of tax incentive.

To achieve such a system would require some sort of quantitative evaluation of land. To start with one could possibly use a points system on a sliding-scale of say 1-5 points for several criteria. For example one could allocate points for a first category based on the degree of infestation by invasive alien plants; a second category based on the size of the property; a third based on the number of indigenous mammal species (or mammalian predators) completely or partially protected by the property; a fourth based on the number of non-indigenous

(alien) mammals on the property; a fifth based on the number of alien, potentially invasive, mammals with regard to ecological invasions, pathogenic invasions, and genetic invasions. Tax rebates on a sliding scale could then be considered; the amounts depending on how many points the properties in question were awarded.

This system could also possibly be developed, by way of example, to allow extra points to be awarded for conserving species not targeted by the game industry, such as small and medium carnivores, rodents, hares, insectivores, bats, hyraxes and primates. Some minor effort would probably be required in estimating population sizes for the larger species, but a simple index would probably suffice.

Trends in Mammalian Conservation Ethics

Historically, the conservation of mammals was essentially the preserve of cultural or political leaders, who set aside areas for "royal" hunts, or at least hunting events for privileged members of the society that then prevailed. Ordinary landowners, however, originally saw little value in wildlife other than as commodities to be eaten or used. Over time, probably associated with socioeconomic advancement, this led to a generally softened approach by landowners towards certain forms of wildlife, particularly those species which represented the occasional source of "biltong" or sport-hunting or which only made occasional depradations on crops. However, this approach was generally not extended to carnivores. The gradual separation of urban and rural life, led to a higher tolerance level for the carnivores in the cities than could be expected from the rural communities, mostly because the urban communities no longer experienced the stock losses that more rural communities still experienced. These stock losses, whether economically significant or not, hindered the development of an holistic conservation ethic. Today the more affluent rural communities, particularly because of more ecologically effective and acceptable control measures can to some extent afford to adopt more conservation/carnivore friendly management practices which have reduced the hunting pressure on indigenous carnivores such as the leopard, but in less affluent communities this is probably less applicable, highlighting the fact that there is still a need for environmental education and innovative problem-solving.

At the opposite extreme from the rural stock farmer and the breeder of rare game taxa, has been the development of the animal rights movement. This grouping has included people with reasonably rational arguments looking for improved wildlife management techniques and the expansion of conservation areas, but also includes those totally opposed to any population management, and those totally opposed to the use of animal protein as a source of food. Clearly the latter have little chance of success in persuading economically depressed societies to change their dietary habits, but could well have an influence on first-world opinions about issues concerning wildlife population management, and more particularly hunting, in such a way that some of the economic objectives of many countries, particularly third-world countries, could be severely compromised *e.g.* elephant culling programmes in national parks; and hunting concessions in Botswana.

A disturbing feature of the inherent economic value of threatened rarer taxa, as alluded to in the opening paragraph of the previous section, has been the major increase in the demand for establishing inappropriate taxa or re-establishing locally extinct taxa. The re-establishment of locally extinct taxa is, in most cases, a laudable objective and only problematic when the historic habitat to which they are being returned has been extensively or completely transformed and/or is too small to accommodate the taxon in question in viable numbers. Table 3 provides a list of all mammalian species considered to be indigenous to the W.C.P. and their conservation status.

The introduction of taxa into the W.C.P. which were never recorded in historic times or which are not known from recent geological periods is, however, problematic for a variety of reasons.

In the first place because of the topographic, climatic, and hence ecological diversity of South Africa, this country is particularly blessed with a fairly spectacular array of mammals (as well as other faunal groups), particularly the ungulates, megaherbivores, and carnivores. Many of these taxa are sought-after either because of their relative rarity, or because of their special "aesthetic" appeal. In parallel with this diversity of mammals, is a vast diversity of pathogens or parasites, and pathogenic vectors (from arthropods, round worms, flat worms, annelids, molluscs, unicellular organisms, bacteria, viruses and lesser groupings). Many of these are essentially endemic to certain regions, but have the potential to become pandemic under certain conditions. Possible climatic change could potentially exacerbate such scenarios. Ill-considered translocation of certain wildlife species could result in some of these pathogens (and parasites) also being transferred to new areas and to species/taxa which have not previously been exposed to them, with potentially disastrous results. It should be a requirement that for all such introductions the environmental impact assessment route should be followed, and that exemption from such a procedure should only be possible with full veterinary, or other agricultural, and conservation approval.

Secondly, some of these taxa introduced to new areas also have the potential to become ecologically invasive or destructive. Although there are probably not many South African taxa which could pose such a threat in the W.C.P., several non-South African taxa do have that potential, particularly animals such as goat-antelopes (such as tahr species), wild species of goat, and wild species of sheep. Apart from such ungulates, other mammalian species adapted to environments similar to those in the Western Cape, especially the montane habitat, from other mammalian orders, also have similar potential *e.g.* rats, mice, rabbits, and cats. Many of our islands provide examples of what enormous damage can be caused.

The third reason for concern is possibly the greatest threat, and that is the fact that many taxa from elsewhere are closely related to taxa which occur naturally in the Western Cape. Recent advances in genetic research have shown that there are often considerable genetic differences between closely related taxa (even within recognized subspecies) from different areas in South Africa, even although no morphological differences are discernible.

Even more disturbing is the fact that apart from the risks involved with hybridization between obviously closely related taxa, there is evidence that fertile hybridization can occur between what are traditionally regarded as good species within the same genus (as has been unequivocally demonstrated between the species in the genera *Connochaetes* and *Kobus*). Still more alarming is the fact that there is now evidence that even intergeneric hybridization can result in the production of fertile hybrids.

These concerns are frequently ignored by those with interests in the game industry, mostly due to ignorance. More disturbing, however, is the fact that many in the game industry who are not ignorant of these facts, are known to have taken advantage of the situation, and it is alleged, with reasonable evidence, that some of these people, have deliberately hybridized taxa in order to provide "new" taxa for the hunting fraternity, even going so far as to produce fertile (*i.e.* self-generating) intergeneric taxa. This, from a conservation perspective, is an entirely unacceptable practice.

Conservation Research and Actions

Historically so-called conservation research concentrated on breeding aesthetically attractive taxa or those taxa traditionally regarded as being sport associated, in order to either re-establish them in the wild, or to place them in those areas where they could be hunted or angled (fished). In terms of mammals this mostly covered a variety of ungulates, mostly indigenous bovids (antelope) and alien cervids (deer).

Subsequent research was initially concentrated on autecological studies of the rarer indigenous ungulates. This developed gradually to include the rarer carnivores and ultimately to all rarer taxa where possible, although there are several taxa occurring in the Western Cape which have not yet been the subject of such projects (*e.g.* the small-spotted cat (*Felis nigripes*); the water rat (*Dasymus incomtus*); and the white-tailed mouse (*Mystromys albicaudatus*). More recently studies have been focused on wider issues and many of these are aimed at studying communities, rather than individual species, in context with their environments, in an effort at understanding ecological processes. Individual specific/subspecific/deme studies are now mostly concentrated on genetic variation and identification.

Ironically enough, although frequently attempted, regular detailed studies on the natural distribution (and the semi-captive distribution of introduced "game" taxa) of mammals have been less than adequate. There are probably a number of reasons to explain this phenomenon (see Lloyd and Millar, 1983). In the first place mammals, particularly the larger ones, are generally the animals most familiar to people and familiarity in this case does lead to "contempt" in a sense, since because people are so familiar with them, they frequently fail to record the localities in which they occur. The mobility and familiarity of certain taxa exacerbates this problem. The lack of familiarity with smaller mammals, however, has also resulted in insufficient information concerning their distribution patterns.

Furthermore because of the diversity of mammals, and the lack of a public sector interested in "mammal-watching" in the same sense that the "bird-watching" community represents, monitoring mammalian distribution is both a time-consuming and expensive pursuit. Declining funding for both conservation organizations and natural history museums has thus also been partially to blame for this paucity.

The most important fields of mammalian research (and action) currently underway include studies on the rarer taxa with specialized habitat requirements, such as the riverine rabbit, and potentially the W.C.P. populations of the laminate vlei rat (*Otomys laminatus*), amongst others. Yet another field of research enjoying considerable attention is the contribution being made to taxonomy by modern molecular biological techniques (a variety of techniques looking at DNA structure). Projects currently targeted for such studies include examining closely related taxa previously identified by more traditional taxonomic techniques in order to confirm these findings, but will hopefully increasingly be focused on taxa with disjunct, or apparently disjunct, distribution ranges (taxa that spring to mind again include *Otomys laminatus*, but would also include, amongst many others, *Otomys saundersiae*, *Mystromys albicaudatus*, *Dasymus incomtus*). Other groups which also require further taxonomic evaluation are the golden-moles (chrysochlorids) and the elephant-shrews (macroscelidids).

Probably the third most important field of mammalian research should also be a continuation of improved problem animal management techniques, which should focus more on solving the true problem, rather than identifying and removing the wild animal which has been incorrectly accused of being the problem.

These three fields are probably the most important avenues to explore still further. Because of its relatively long history in South Africa, mammalogy has been more fortunate than many of the other zoological subdisciplines and much of the groundwork has been done. Apart from the above three fields, the only other important facet is to obtain better information on distribution and habitat requirements, particularly for many of the smaller mammals.

In terms of institutions currently or historically engaged on mammalian research in general, the list is enormous. In brief we will mention the more important overseas institutions which have been involved in mammalian research in the W.C.P., followed by local centres of tertiary education and the specialized natural history centres.

Overseas Institutions which have contributed considerably to mammalogical studies in Africa, including the W.C.P.

American Museum of Natural History
Smithsonian Institution
British Museum (Natural History)
Zoological Society (London)
IUCN Species Survival Commission - various Specialist Groups

American Society of Mammalogists
Zoological Society for the Conservation of Species and Populations (Z.S.C.S.P - Germany)

Local Tertiary Education Institutions which have contributed considerably to mammalogical studies in the W.C.P.

University of the Witwatersrand - Science Faculty
University of Pretoria - Science Faculty; Veterinary Faculty; Agriculture Faculty - especially the Mammal Research Institute and the Eugene Marais Chair of Wildlife Management
University of Cape Town - Science Faculty; Medical Faculty
University of Stellenbosch - Science Faculty; Forestry Faculty; Agriculture Faculty
University of Natal - (both Durban and Pietermaritzburg campuses) - Science Faculty
University of the Western Cape - Science Faculty
University of Port Elizabeth - Science Faculty
Rhodes' University - Science Faculty
Technikon RSA
Cape Technikon
Port Elizabeth Technikon (Saasveld Campus)

Specialized Natural History Centres which have contributed considerably to mammalogical studies in the W.C.P.

Department of Water Affairs and Forestry (D.W.A.F.) - the erstwhile S.A. Forestry Research Institute
Department of Environmental Affairs and Tourism (D.E.A.T.) - Division of Marine and Coastal Management; South African National Parks
Department of Agriculture (National) - various institutes
Provincial Conservation Authorities - especially W.C.N.C.B., but also others
South African Museum
Transvaal Museum
McGregor Museum
Amathole Museum (formerly Kaffrarian Museum)
Albany Museum
Port Elizabeth Museum
Durban Natural History Museum

Status of Mammalian Knowledge

Mammalogy is one of the fields of zoology which has been fortunate enough to have a relatively long history, particularly with respect to distribution records and studies of the megaherbivores and other "traditional game" species and the larger carnivores. These groups, although targeted by early hunters and in many cases almost completely exterminated, at least in certain areas, were the subjects of numerous narratives and many of the earliest studies. Because of their relative rarity, their relatively large size and conspicuous nature, and also simply because of the fact that they were mammals (namely animals with which human-beings, also mammals, can most closely associate) many of these animals also became the subjects of the first autecological studies in the relatively recent subdisciplines of ecology and nature conservation science. The status of knowledge of these groups therefore rivals, and probably exceeds, that acquired in the general field of ornithology, despite not possessing a lay interest group equivalent to the birdwatchers who provide so much information in the field of ornithology. However, the smaller mammals, even many of the more common species, particularly amongst the rodents, have not, until recently, been able to solicit anywhere near as much attention as the larger members of their class. In recent years this has been more adequately addressed and it is probably true to say that today the most poorly understood mammals, apart from marine mammals, would be represented by the rarer small mammals. This is partially because they can be difficult to locate, partially because some of them occupy habitats in remote areas, partially because of the fact that many people are biased against rodents of any sort, including any animals that vaguely resemble rodents.

Despite the fact that some of these smaller mammals are not well documented in terms of their general biology, their ecological requirements, and their distributional limits, it would be fair to say that in general the status of mammalian knowledge can be considered reasonably sound, with considerable attention currently being focused on the rarer taxa. Academic institutions, particularly the Mammal Research Institute and the Transvaal Museum, but including several other universities and other natural history museums, have ensured that these rarer and less well understood taxa are the focus of their research programmes. One of the most important other focal points currently receiving considerable attention is the topic of molecular biological taxonomic techniques, especially those employing a wide range of techniques to analyse and evaluate mitochondrial and nuclear DNA.

Recommendations towards the Conservation of Mammals

The conservation of mammals has had an historical advantage in many respects when compared with early conservation actions with respect to other vertebrates and also with respect to the invertebrates. As alluded to earlier, this is probably the result of mammals being more familiar to human society than the other groups of animals. However this "charitable" attitude displayed towards mammals relative to other faunal elements was never absolute, inasmuch as certain types of mammal (mostly those that were considered to be palatable and which were thus termed "game") received considerable protection (with a few notable exceptions) whereas others were (and in some cases still are) the targets of relentless persecution. The latter include many of the carnivores, especially lions, cheetahs, wild dogs and spotted hyenas (which were all hunted to extinction in the W.C.P.); brown hyenas, with only the occasional straggler being reported in the province; and the leopard, which still survives and which is now protected, but which is still occasionally hunted (normally (?) via the permit system) because of attacks on livestock. Included within this group of persecuted mammals (mostly carnivores), however, are two of our commoner primates, namely the baboon (because of raids on both crops and smaller livestock) and the vervet monkey (mostly because of raids on cereal, vegetable and fruit crops). Although many private ecotourism developments apply to keep some of the more spectacular species on their properties in the

W.C.P. most of these developments are incapable of supporting viable self-sustaining populations, and it is therefore important to ensure the creation of large statutory conservation areas (whether through consolidation of existing reserves and/or purchase of further extensive areas) in order to re-establish viable self-sustaining populations of those species which have either become extinct in the W.C.P. or nearly so and to maintain those species still surviving which are considered to be incompatible with agriculture. This is an achievable goal within the W.C.P. even if only restricted to two or three conservation areas and even if genetic viability cannot be attained without management intervention. Not only would such re-establishments provide an ecotourism attraction to these conservation areas but as management tools they would play an important evolutionary role in maintaining the genetic fitness of the prey species on which they would have to survive. Concomitant with such reintroductions to such extensive conservation areas ("mega-parks") would be the reintroduction of the locally extinct megaherbivores as well, such as elephant, black rhinoceros and hippopotamus, and the other locally extinct herbivores which have not yet been re-established on many of the reserves. In the latter case the species frequently absent are taxa such as Cape mountain zebra, red hartebeest, and eland, all of which can do reasonably well, even in montane habitats. Cape mountain zebras, however, do need hard (rocky) substrates, which is why they were commonly found in montane habitats. All three taxa were historically fairly widespread within the W.C.P. In the case of both the megaherbivores and larger carnivores, as alluded to earlier, population sizes would probably be lower than would be ideally required to maintain genetic fitness and variation, due to genetic drift and other mechanisms eroding genetic variability, but these shortcomings can be managed relatively simply and cheaply through occasional strategic translocations of individuals. The C.A.P.E. programme includes projects aimed at establishing such extensive conservation areas, which could be enhanced through the incorporation of privately owned land in the form of private nature reserves and conservancies, all managed coooperatively.

The smaller carnivores which are also targeted by agricultural communities, are more fortunate in that their densities are generally higher and the likelihood of imminent extinction considerably lower than those of their larger relatives. Nevertheless some of the smaller carnivores in the W.C.P. appear to occur in low densities and thus need additional measures aimed at their protection. Although to some extent extensive conservation areas designed to accommodate self-sustaining populations (albeit probably small) of larger carnivores and megaherbivores, will also fortuitously provide refuge for an enormous suite of smaller organisms, some of the organisms (in this case mammals) will have natural distribution ranges which do not overlap at all, or only overlap partially, with the geographic locations of these extensive areas.

The carnivore species for which additional conservation measures should be considered as priorities are the small-spotted (or black-footed) cat (*Felis nigripes*), the serval (*Felis serval*), and the white-naped (or snake-) weasel (*Poecilogale albinucha*). Apart from identifying those areas, including nature reserves, in which they still survive, the public at large, and more specifically the landowners in areas where these animals tend to be concentrated, should be targeted to lobby for formal statutory conservation areas and/or to establish private initiatives (*e.g.* conservancies; private nature reserves; local authority nature reserves; and sites of conservation significance) highlighting or focusing on what are local natural history assets, and in so doing, re-instil a sense of pride in local natural resources.

Although, it might possibly have come too late, the programme currently aimed at conserving the riverine rabbit represents a good example of such an approach. In this particular case the problem is exacerbated by the fact that the animal in question has a linear distribution in a very restricted type of environment which is under considerable threat of irreversible transformation, namely the alluvial flood plains of certain Karooid river systems. Apart from their inherent fragility and dynamic nature due to flood events, these habitats also represent arable areas for the agricultural communities and, due to the relatively high water tables, also represent "emergency" forage areas for livestock during periods of prolonged drought.

Rivers, and wetlands in general, whether perennial or temporary, represent important habitats for a wide variety of animals. Apart from the obvious dependency on water by truly aquatic organisms such as a multitude of invertebrates, fish, amphibians, water-associated reptiles and birds, there is a wide variety of mammals, other than the riverine rabbit, which to a greater or lesser extent are dependent on these wetlands, and particularly rivers. One immediately thinks of species such as the Cape clawless otter (*Aonyx capensis*), the water mongoose (*Atilax paludinosus*), and the water rat (*Dasymus incomtus*), not that these are necessarily currently faced with major threats, but many others also utilize not only the water but the riparian and associated vegetation for both food and shelter. However, rivers also play an equally important role as ecological corridors along which animals can disperse from one type of terrestrial environment to a different terrestrial environment. The fact that leopards have re-established themselves on De Hoop Nature Reserve is probably a good example of such activity in practice. Leopards were thought to have been eliminated from the reserve about 100 years ago and the nearest surviving animals in recent times have been those occurring on the mountains near Swellendam. The most likely route to have been followed to prevent detection would have been down the Breede River.

The consequence of these dependencies is therefore a need to promote river and wetland conservation at least as vigorously as lowland conservation. Attention should be focused on trying to identify at least three to five rivers currently passing through or lying adjacent to some of our existing reserves, and developing a conservation programme, including restorative ecological techniques where needed, from the catchment area through to the coastal environment. Several such possibilities still exist, but it is important to act now before further development prevents such action. Apart from publicizing the need for such projects, action needs to be initiated by allowing for such projects to be incorporated into general landscape

planning, such as the spatial development frameworks and integrated development plans.

Similarly at least two areas that also require further protection based on the presence of rare or threatened mammals are firstly the marine environment, with a need for further marine protected areas (MPAs), particularly for the cetaceans and, secondly, the forest remnants, which are mostly protected, but highly fragmented and which could probably benefit from consolidation of these fragments into larger units. Not many species of fruit bat occur in the W.C.P. but all of them are dependent on the fruits available in indigenous forests, and there is really only one species, namely the Egyptian fruit bat, which is capable of utilizing other sources of fruit.

In terms of the conservation of the majority of insectivorous bats, all caves (and mines containing bats) should be identified (much has already been done), monitored and the more important of these should be given statutory protection.

Apart from identifying specific geographic locations for conservation purposes, however, there are other actions needed to improve mammalian conservation which include improved legislation, administrative guidelines and minimum standards, particularly associated with the hunting and animal translocation profession. One vital piece of legislation required is a national translocation policy to reduce the risks associated with the introduction of alien taxa into new environments, including taxa indigenous to South Africa translocated to areas outside their natural distribution range. An administrative need is for a formal procedure to register institutions such as zoological gardens, animal dealers, rehabilitation centres, *etc.* and to provide a set of minimum standards for each of these types of institution.

Finally, a formal monitoring programme for all taxa listed in local or international Red Data Books or Red Lists should be established, much akin to the bird and frog atlassing projects that have been so succesful. Tertiary education institutions, natural history museums, conservation authorities and other interested organizations can all play a role in such monitoring, particularly of precise locality data and population sizes. In this way, even species such as the white-tailed mouse, whose ecological requirements are effectively unknown to us currently, might face a brighter future.

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Table 3. Mammalian species of the W.C.P., their common names, and their conservation status.

Taxon	English Name	IUCN Category	SA RDB Category	CITES	Ordinance
Alcelaphus buselaphus	Red hartebeest	Null	Null	Null	Schedule II
Antidorcas marsupialis	Springbuck	Null	Null	Null	Schedule II
Damaliscus dorcas dorcas	Bontebok	Null	Null	Null	Schedule II
Hippotragus leucophaeus	Bluebuck	Null	Extinct	Null	Null
Oreotragus oreotragus	Klipspringer	Null	Null	Null	Schedule II
Oryx gazella	Gemsbok	Null	Null	Null	Schedule II
Pelea capreolus	Grey rhebuck	Null	Null	Null	Schedule II
Philantomba monticola	Blue duiker	Null	Rare	Null	Schedule II
Raphicerus campestris	Steenbok	Null	Null	Null	Schedule II
Raphicerus melanotis	Grysbok	Null	Null	Null	Schedule II
Redunca fulvorufula	Mountain reedbuck	Null	Null	Null	Null
Sylvicapra grimmia	Common duiker	Null	Null	Null	Schedule II
Syncerus caffer	Buffalo	Null	Null	Null	Schedule II
Taurotragus oryx	Eland	Null	Null	Null	Schedule II
Tragelaphus scriptus	Bushbuck	Null	Null	Null	Schedule II
Tragelaphus strepsiceros	Kudu	Null	Null	Null	Schedule II
Hippopotamus amphibius	Hippopotamus	Null	Rare	Appendix II	Schedule II
Phacochoerus aethiopicus	Warthog	Null	Null	Null	Schedule II
Potamochoerus porcus	Bushpig	Null	Null	Null	Null
Canis mesomelas	Black-backed jackal	Null	Null	Null	Null
Lycaon pictus	Wild dog	Endangered	Endangered	Null	Null
Otocyon megalotis	Bat-eared fox	Null	Null	Null	Schedule II
Vulpes chama	Cape fox	Null	Null	Null	Schedule II
Acinonyx jubatus	Cheetah	Vulnerable	Out Of Danger	Appendix I	Schedule I
Felis caracal	Caracal	Null	Null	Appendix II	Null
Felis lybica	African wild cat	Null	Vulnerable	Appendix II	Null
Felis nigripes	Black-footed cat	Null	Rare	Appendix I	Schedule II
Felis serval	Serval	Null	Rare	Appendix II	Schedule II
Panthera leo	Lion	Null	Null	Appendix II	Schedule II
Panthera pardus	Leopard	Null	Rare	Appendix II	Schedule II
Crocuta crocuta	Spotted hyaena	Null	Null	Null	Null
Hyaena brunnea	Brown hyaena	Vulnerable	Rare	Null	Schedule II
Aonyx capensis	Clawless otter	Null	Null	Appendix II	Null
Ictonyx striatus	Striped polecat	Null	Null	Null	Null
Mellivora capensis	Honey badger	Null	Vulnerable	Null	Schedule II
Poecilogale albinucha	Striped weasel	Null	Rare	Null	Schedule II
Arctocephalus pusillus	Cape fur seal	Null	Null	Appendix II	Null
Arctocephalus tropicalis	Subantarctic fur seal	Null	Null	Appendix II	Null
Hydrurga leptonyx	Leopard seal	Null	Null	Null	Null

Table 3. *(Continued)*

Lobodon carcinophagus	Crabeater seal	Null	Null	Null	Null
Mirounga leonina	Southern elephant seal	Null	Null	Appendix II	NULL
Proteles cristatus	Aardwolf	Null	Rare	Null	Schedule II
Atilax paludinosus	Water mongoose	Null	Null	Null	Null
Cynictis penicillata	Yellow mongoose	Null	Null	Null	Null
Galerella pulverulenta	Small grey mongoose	Null	Null	Null	Null
Genetta genetta	Small-spotted genet	Null	Null	Null	Null
Genetta tigrina	Large-spotted genet	Null	Null	Null	Null
Herpestes ichneumon	Large grey mongoose	Null	Null	Null	Null
Suricata suricatta	Suricate	Null	Null	Null	Null
Balaena glacialis	Right whale	Endangered	Null	Null	Null
Caperea marginata	Pygmy right whale	Insufficiently Known	Null	Appendix I	Null
Balaenoptera acutorostrata	Minke whale	Insufficiently Known	Null	Appendix I	Null
Balaenoptera borealis	Sei whale	Vulnerable	Null	Appendix I	Null
Balaenoptera edeni	Bryde's whale	Insufficiently Known	Null	Appendix I	Null
Balaenoptera musculus	Blue whale	Endangered	Null	Appendix I	Null
Balaenoptera physalus	Fin whale	Vulnerable	Null	Appendix I	Null
Cephalorhynchus heavisidii	Heaviside's dolphin	Insufficiently Known	Null	Null	Schedule II
Delphinus delphis	Common dolphin	Insufficiently Known	Null	Null	Schedule II
Feresa attenuata	Pygmy killer whale	Insufficiently Known	Null	Null	Schedule II
Globicephala macrorhynchus	Short-finned pilot whale	Insufficiently Known	Null	Null	Schedule I and Ii
Globicephala melaena	Long-finned pilot whale	Insufficiently Known	Null	Null	Schedule II
Grampus griseus	Risso's dolphin	Insufficiently Known	Null	Null	Schedule II
Lagenorhynchus obscurus	Dusky dolphin	Insufficiently Known	Null	Null	Schedule II
Neophocaena phocaenoides	Finless porpoise	Insufficiently Known	Null	Appendix I	Schedule II
Orcinus orca	Killer whale	Insufficiently Known	Null	Null	Schedule II
Peponocephala electra	Melon-headed whale	Insufficiently Known	Null	Null	Schedule II
Pseudorca crassidens	False killer whale	Insufficiently Known	Null	Null	Schedule II
Sousa plumbea	Humpback dolphin	Insufficiently Known	Null	Appendix I	Schedule II
Stenella attenuata	Spotted dolphin	Insufficiently Known	Null	Null	Schedule II
Stenella coeruleoalba	Striped dolphin	Insufficiently Known	Null	Null	Schedule II
Tursiops aduncus	Indian Ocean bottlenosed dolphin	Null	Null	Null	Schedule II
Tursiops truncatus	Atlantic Ocean bottlenosed dolphin	Insufficiently Known	Null	Null	Schedule II
Megaptera novaeangliae	Humpback whale	Vulnerable	Null	Appendix I	Null
Kogia breviceps	Pygmy sperm whale	Insufficiently Known	Null	Null	Null
Kogia simus	Dwarf sperm whale	Insufficiently Known	Null	Null	Null
Physeter macrocephalus	Sperm whale	Insufficiently Known	Null	Null	Null
Berardius arnuxii	Arnoux's beaked whale	Insufficiently Known	Null	Appendix I	Null
Hyperoodon planifrons	Southern bottlenose whale	Insufficiently Known	Null	Appendix I	Null
Mesoplodon densirostris	Blainville's beaked whale	Insufficiently Known	Null	Null	Null

Table 3. *(Continued)*

Mesoplodon grayi	Gray's beaked whale	Insufficiently Known	Null	Null	Null
Mesoplodon layardii	Layard's beaked whale	Insufficiently Known	Null	Null	Null
Mesoplodon mirus	True's beaked whale	Insufficiently Known	Null	Null	Null
Ziphius cavirostris	Cuvier's beaked whale	Insufficiently Known	Null	Null	Null
Taphozous mauritianus	Mauritian tomb bat	Null	Null	Null	Schedule II
Sauromys petrophilus	Flat-headed free-tailed bat	Null	Null	Null	Schedule II
Tadarida aegyptiaca	Egyptian free-tailed bat	Null	Null	Null	Schedule II
Tadarida ventralis	Giant African free-tailed bat	Null	Indeterminate	Null	Schedule II
Nycteris thebaica	Egyptian slit-faced bat	Null	Null	Null	Schedule II
Epomophorus wahlbergi	Wahlberg's epauletted fruit bat	Null	Null	Null	Null
Rousettus aegyptiacus	Egyptian fruit bat	Null	Null	Null	Null
Rhinolophus capensis	Cape horseshoe bat	Null	Null	Null	Schedule II
Rhinolophus clivosus	Geoffroy's horseshoe bat	Null	Null	Null	Schedule II
Eptesicus capensis	Cape serotine bat	Null	Null	Null	Schedule II
Eptesicus hottentotus	Long-tailed serotine bat	Null	Null	Null	Schedule II
Eptesicus melckorum	Melck's serotine bat	Null	Null	Null	Schedule II
Kerivoula lanosa	Lesser woolly bat	Null	Indeterminate	Null	Schedule II
Laephotis namibensis	Namib long-eared bat	Null	Null	Null	Schedule II
Miniopterus fraterculus	Lesser long-fingered bat	Null	Null	Null	Schedule II
Miniopterus schreibersii	Schreiber's long-fingered bat	Null	Null	Null	Schedule II
Myotis lesueuri	Lesueur's wing-gland bat	Null	Indeterminate	Null	Schedule II
Myotis tricolor	Temminck's hairy bat	Null	Null	Null	Schedule II
Procavia capensis	Rock dassie	Null	Null	Null	Null
Amblysomus hottentotus	Hottentot golden mole	Null	Null	Null	Null
Amblysomus iris	Zulu golden mole	Indeterminate	Indeterminate	Null	Null
Chlorotalpa duthieae	Duthie's golden mole	Rare	Indeterminate	Null	Null
Chlorotalpa sclateri	Sclater's golden mole	Rare	Indeterminate	Null	Null
Chrysochloris asiatica	Cape golden mole	Null	Null	Null	Null
Cryptochloris zyli	Van Zyl's golden mole	Indeterminate	Indeterminate	Null	Null
Eremitalpa granti	Grant's golden mole	Rare	Rare	Null	Null
Crocidura cyanea	Reddish-grey musk shrew	Null	Null	Null	Schedule II
Crocidura flavescens	Greater musk shrew	Null	Null	Null	Schedule II
Myosorex longicaudatus	Long-tailed forest shrew	Insufficiently Known	Indeterminate	Null	Schedule II
Myosorex varius	Forest shrew	Null	Null	Null	Schedule II
Suncus varilla	Lesser dwarf shrew	Null	Null	Null	Schedule II
Bunolagus monticularis	Riverine hare	Endangered	Endangered	Null	Schedule I
Lepus capensis	Cape hare	Null	Null	Null	Null
Lepus saxatilis	Scrub hare	Null	Null	Null	Null
Pronolagus rupestris	Smith's red hare	Null	Null	Null	Null
Elephantulus edwardii	Cape rock elephant-shrew	Null	Null	Null	Schedule II

Table 3. *(Continued)*

Elephantulus rupestris	Smith's rock elephant-shrew	Null	Null	Null	Schedule II
Macroscelides proboscideus	Round-eared elephant-shrew	Null	Null	Null	Schedule II
Equus burchellii	Burchell's zebra	Null	Null	Null	Schedule II
Equus quagga	Quagga	Null	Null	Null	Null
Equus zebra zebra	Cape Mountain zebra	Vulnerable	Null	Appendix I and II	Null
Diceros bicornis	Black rhinoceros	Endangered	Vulnerable	Appendix I	Schedule I
Cercopithecus aethiops	Vervet monkey	Null	Null	Appendix II	Null
Papio ursinus	Chacma baboon	Null	Null	Appendix II	Null
Loxodonta africana	African Elephant	Vulnerable	Out of Danger	Appendix I and II	Schedule II
Bathyergus suillus	Cape dune molerat	Null	Null	Null	Null
Cryptomys hottentotus	Common molerat	Null	Null	Null	Null
Georychus capensis	Cape molerat	Null	Null	Null	Null
Graphiurus murinus	Woodland dormouse	Null	Null	Null	Null
Graphiurus ocularis	Spectacled dormouse	Null	Rare	Null	Null
Hystrix africaeaustralis	Porcupine	Null	Null	Null	Null
Acomys subspinosus	Cape spiny mouse	Null	Null	Null	Null
Aethomys granti	Grant's rock mouse	Null	Indeterminate	Null	Null
Aethomys namaquensis	Namaqua rock mouse	Null	Null	Null	Null
Dasymys incomtus	Water rat	Null	Indeterminate	Null	Null
Dendromus melanotis	Grey climbing mouse	Null	Null	Null	Null
Dendromus mesomelas	Brants's climbing mouse	Null	Null	Null	Null
Dendromus mystacalis	Chestnut climbing mouse	Null	Null	Null	Null
Desmodillus auricularis	Short-tailed gerbil	Null	Null	Null	Null
Gerbillurus paeba	Hairy-footed gerbil	Null	Null	Null	Null
Malacothrix typica	Large-eared mouse	Null	Null	Null	Null
Mastomys coucha	Multimammate mouse	Null	Null	Null	Null
Mastomys natalensis	Natal multimammate mouse	Null	Null	Null	Null
Mus minutoides	Pygmy mouse	Null	Null	Null	Null
Myomyscus verreauxi	Verreaux's mouse	Null	Null	Null	Null
Mystromys albicaudatus	White-tailed rat	Null	Vulnerable	Null	Null
Otomys irroratus	Vlei rat	Null	Null	Null	Null
Otomys laminatus	Laminate vlei rat	Null	Null	Null	Null
Otomys saundersiae	Saunders's vlei rat	Null	Null	Null	Null
Otomys unisulcatus	Bush Karroo rat	Null	Null	Null	Null
Parotomys brantsii	Brants's whistling rat	Null	Null	Null	Null
Petromyscus collinus	Pygmy rock mouse	Null	Indeterminate	Null	Null
Rhabdomys pumilio	Striped mouse	Null	Null	Null	Null
Saccostomus campestris	Pouched mouse	Null	Null	Null	Null
Steatomys krebsii	Krebs's fat mouse	Null	Null	Null	Null
Tatera afra	Cape gerbil	Null	Null	Null	Null
Orycteropus afer	Aardvark	Null	Vulnerable	Null	Schedule II