A habitat suitability assessment for the introduction of Black Rhinoceros and Mountain Zebra to the Namaqua National Park and Upland priority region in the Succulent Karoo Biome

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1. EXECUTIVE SUMMARY

The aim of the study was to determine the potential suitability of areas in Namaqualand for the introduction of mountain zebra and black rhinoceros. These assessments were based upon a set of ecological and conservation criteria. Of particular concern for both species is the availability of natural surface water on a year-round basis. Given the demonstrated risks to biodiversity associated with artificial waterpoints, it is recommended that such waterpoints should not be provided.

By reviewing the historical literature and surveying the potential areas, we conclude that 1) Hartmann's mountain zebra occurred in the area, but there are no historical records for black rhinoceros, 2) the Rooiberg catchment area and Namaqua National Park are potentially suitable for the re-introduction of mountain zebra, and 3) the areas are not suitable for black rhinoceros.

As the potential population sizes of mountain zebra in both the Rooiberg catchment area (115 individuals) and Namaqua National Park (359 individuals) are relatively small, they would be vulnerable to the effects of inbreeding depression and genetic drift. Thus, if mountain zebra are re-introduced, the populations will need to be monitored, and managed as part of a metapopulation.

2. TERMS OF REFERENCE

Conservation International (CI) – South Africa contracted the Terrestrial Ecology Research Unit to provide a habitat suitability assessment for the potential re-introduction of indigenous herbivores, particularly mountain zebra and black rhinoceros, to the Namaqua National Park and Upland priority region.

The assessment had to include the following:

1. The historical occurrence of mountain zebra and black rhinoceros in the region.
2. The potential suitability of different vegetation types in the region for the re-introduction of mountain zebra and black rhinoceros.
3. The management and risk requirements of mountain zebra and black rhinoceros for re-introduction.
4. Recommendations for the development of an implementation plan for re-introduction.

3. INTRODUCTION

The Succulent Karoo Biome is recognised as a global biodiversity hotspot (Mittermeier *et al*. 2000). Currently, only a very small portion (< 4 %) of the area is conserved in formal conservation areas in the Namaqualand region (Cowling and Pierce 1999). The remaining area is used extensively for agricultural purposes, or by communal farmers for livestock grazing. Although the area is generally recognised more for its floristic biodiversity, historically the Succulent Karoo supported a relatively high diversity of medium- and large sized mammals, most of which have been extirpated in the last 350 years (Skead 1980).

In an attempt to promote the restoration of natural ecosystems in the Succulent Karoo Biome, Conservation International, in partnership with the Kamiesberg Municipality and South African National Parks, are investigating the potential of introducing indigenous herbivores to the Namaqua National Park and Upland priority region. It is hoped that the potential areas for re-introduction will not only provide buffer conservation areas to the current Namaqua National Park, but also increase economic opportunities (provided through ecotourism and wildlife sales) in this globally recognized biodiversity hotspot.

This report provides information relating to the potential suitability of four proposed areas in the greater Kamiesberg Municipality for the re-introduction of mountain zebra and black rhinoceros.

4. PROPOSED AREAS

Four areas (Figure 1) were proposed for the potential re-introduction of mountain zebra and black rhinoceros to the Kamiesberg Municipality. These areas (from east to west) are:

1. *Platbakkies* (*ca*. 40 422 ha) – The area stretches from the east of the Kamiesberg range into the sandplains of Bushmanland. Rainfall is generally low (100-300 mm/yr), and erratic with peaks towards the end of summer and in autumn (Cowling and Pierce 1999). The area falls within the Nama-Karoo Biome (Low and Rebelo 1996) with characteristic *karoobossies*. After periods of high rainfall, tufts of short-lived, palatable grasses may be found throughout (Cowling and Pierce 1999).

2. *Rooiberg catchment* (*ca*. 44 675 ha) – The Rooiberg, Weeskind and Eselkop peaks are situated within the Kamiesberg range, and forms the main catchment for the Kamiesberg Municipality. Rainfall is 150 to >300 mm/yr, occurring mostly in the winter months from May to August (Cowling and Pierce 1999). The higher and wetter parts of the Kamiesberg range support Namaqualand Granite Renosterveld (Mucina and Rutherford 2004), which is dominated by tall daisy shrubs (dominated by renosterbos *Elytropappus rhinocerotis*) and relatively few succulents (Cowling and Pierce 1999). At lower elevations, the landscapes are rugged and broken with large granite outcrops. These areas are characterised by succulents, taller shrubs and low trees that are scattered throughout the landscape (Cowling and Pierce 1999); more formally known as Namaqualand Klipkoppe Shrubland (Mucina and Rutherford 2004). There is a pronounced difference in plant cover between east and west facing slopes, presumably due to differences in moisture regimes. Grasses are generally only common in well managed veld (Cowling and Pierce 1999).

3. *Spoegrivier* (*ca*. 7 794 ha) – The area stretches from the Spoegrivier communal area in the west to the Tweerivier communal area further east. Rainfall generally peaks during the winter months from May – August (Cowling and Pierce 1999). The area is characterised by Namaqualand Klipkoppe Shrubland, with Namaqualand Heuweltjieveld occurring mainly in the valley bottoms (Mucina and Rutherford 2004). Namaqualand Heuweltjieveld is a dwarf to low shrubland, dominated by leaf succulents (Cowling and Pierce 1999).

4. *Namaqua National Park* and surroundings (*ca*. 244 140 ha) – The area includes the current Namaqua National Park in the north-east and the extensive coastal plains adjacent to the Atlantic Ocean. The coastal plains are generally sandy and dominated by duneveld and strandveld (Mucina and Rutherford 2004). The mountainous area towards the north-east corner of the Park has the highest plant cover, with Namaqualand Heuweltjieveld in the valley bottoms and Namaqualand Klipkoppe Shrubland on the slopes (Mucina and Rutherford 2004).

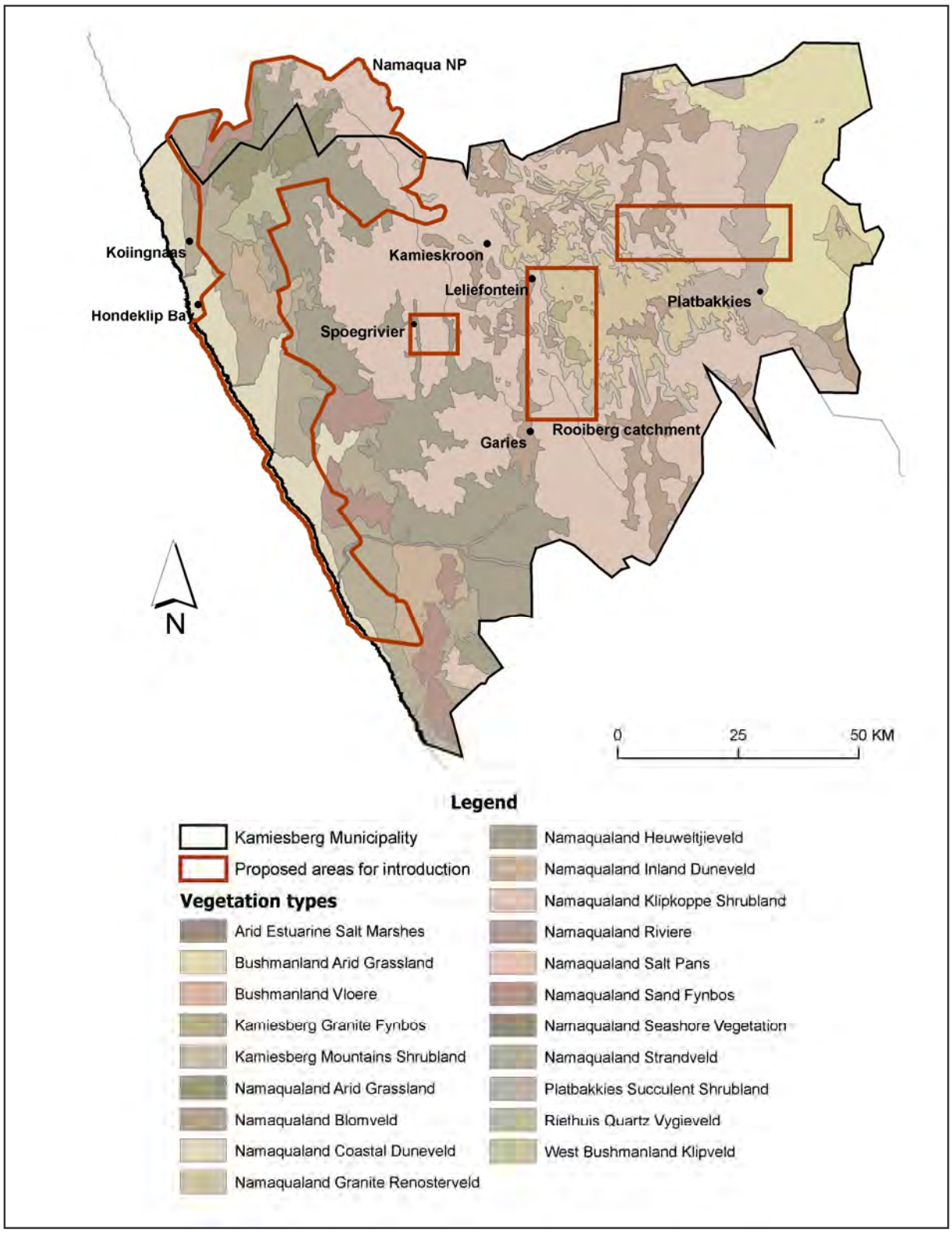

Figure 1. The areas assessed for the potential re-introduction of mountain zebra and black rhinoceros to the Kamiesberg Municipality.

5. APPROACH

In order to assess the suitability of habitats for the potential re-introduction of mountain zebra and black rhinoceros, it was first necessary to develop an understanding of the historical distribution of these species in the Namaqualand region. Publications by Du Plessis (1969), Skead (1980) and Rookmaaker (1989) summarise the written records of early residents and travellers to the area with respect to mammal occurrences. The principal followed here was that species should not be introduced into areas in which they did not occur historically. This follows conventional ecological understanding, as well as national (NEMA: Biodiversity) and international (Convention for Biodiversity Conservation) legislation.

The specific ecological requirements of mountain zebra and black rhinoceros further provided a tool with which we assessed the suitability of the four proposed areas. We focused on four key points that would be required for a successful re-introduction. These points included:

1. *Space* – The long-term growth and success of many large mammal species is linked to the size of the area in which they live. Larger areas are generally able to maintain large, viable populations and are better suited to facilitate natural process (e.g. dispersal, seasonal movements and social interactions).
2. *Substrate* – In many instances, the substrate will determine an animal's use of a particular habitat. In this regard, mountain zebras require hard substrates to wear down their hooves, while black rhinoceros are generally unable to traverse steep, rocky terrain.
3. *Forage* – The availability of food, especially during the dry season, is the most important resource determining the quality of a habitat for any animal. Thus, as mountain zebras are grazers and black rhinoceros browsers, the availability of grass and browse respectively throughout the year will be critical for their survival in the region.

4. *Surface water* – One of the distinguishing features of Namaqualand is the very low availability of natural surface water on a year-round basis. Thus, as mountain zebra and black rhinoceros are both dependent on drinking daily, the availability of year-round natural surface water will be critical to determining where they will be able to survive and thus may be re-introduced.

We therefore considered areas suitable for re-introduction if the species had occurred there historically, and if the ecological requirements of the species could be met in these areas.

Due to the variability of vegetation types between areas (e.g. vegetation cover, plant physiognomy, degree of rockiness), the habitat suitability assessments could not be generalised across vegetation types. These assessments are therefore area specific, rather than vegetation type specific.

6.1 Historical occurrence

Mountain zebra historically ranged through the Kamiesberg in Namaqualand (Skead 1980), but are not found there today. The actual date when zebra disappeared from Namaqualand is uncertain. John Barrow did not see them when he explored the region in 1798 (Skead 1980). Dr E.L. Gill (the then director of the South African Museum), however, stated in the Cape Times (1931) that a few mountain zebra had been seen in the Kamiesberg about 160 km south of Port Nolloth in 1912 (Skead 1980). These individuals, however, were not present when Gill wrote the article in 1931.

With the confirmation of their historical presence, questions arise as to whether these zebra were Cape mountain zebra (*E. zebra zebra*) or Hartmann's mountain zebra (*E. zebra hartmannae*). From a series of historical reports, Rookmaaker (1989) was unable to determine even tentative historical boundaries of the two mountain zebra sub-species. In fact, he states, "If anything, they [the historical records] are more confusing than otherwise." Du Plessis (1969), also, found it hard to define the historical ranges of the two sub-species and suggested that the ranges of Cape and Hartmann's mountain zebra may have overlapped in the region around the Orange River, including Namaqualand.

In contrast, Skead (1980) indicates that the zebras found in Namaqualand were most likely Hartmann's mountain zebra. Shortridge (1934, as cited in Skead 1980) suggests that the Kamiesberg may have been the southern-most extension of the Hartmann's range. Sidney (1965) supports this and suggests that the mountain zebras in the Kamiesberg, Namaqualand were 'most probably' Hartmann's mountain zebras. The IUCN Equid Specialist Group (Novellie *et al.* 2002) suggests that the two species were separated in the Northern Cape by a large stretch of flat land (unsuitable habitat) stretching between the Kamiesberg in the North and the Cedarberg and Bokkeveldberg in the South. Novellie *et al.* (2002) hypothesized that Hartmann's mountain zebras

would have been restricted to the north of this plain, while Cape mountain zebra would have been in the South.

Based on the above, we conclude that Hartmann's mountain zebra would be the appropriate sub-species for consideration of re-introduction into the study area.

6.2 Ecological requirements and general biology

Hartmann's mountain zebras are adapted to rugged terrain. They typically prefer the ecotone that combines mountainous and sandy flat areas (Skinner and Smithers 1990). Zebras may move between these habitats due to seasonal changes in food and water availability, and the need to seek shelter (Penzhorn 1982). However, the harder and faster growing hooves of mountain zebras inhibit their habitation of sandy flat plains for long periods (Skinner and Smithers 1990). Mountain zebras have been known to move up to 100 km between areas where local rain has improved grazing (Skinner and Smithers 1990). During the heat of the day, they may rest in the shade of trees, and will use kloofs as shelter from cold winds (Skinner and Smithers 1990). For example, Joubert (1971) recorded that Hartmann's mountain zebras left the pre-Namib plains of Kaokoland and moved back to the protection of the escarpment at the onset of the first cold weather.

Hartmann's mountain zebras are bulk grazers and thus dependent on processing large quantities of forage (Saltz 2002). Like Cape mountain zebra, Hartmann's favour habitats with a high abundance of palatable grasses (Novellie and Winkler 1993, Novellie 1994, Watson 2005). The late dry season is usually a critical period for their survival, primarily due to the deteriorating quality of food (Penzhorn 1988). Although mountain zebras will eat a small amount of browse (e.g. ephemerals), it happens quite rarely (Penzhorn 1982, Skinner and Smithers 1990).

As mountain zebras need to drink daily, the availability of water limits their distribution (Joubert 1971 as cited in Skinner and Smithers 1990, Saltz *et al.* 2000). On the pre-Namib plains of Namibia, Coetzee (1969) recorded that mountain zebras can forage only up to 20 km away from

water. In times of the year when surface water is not readily available, they may dig for it in sandy riverbeds (Skinner and Smithers 1990).

Mountain zebras live within either breeding herds that comprise a dominant stallion, 1-5 mares, and their foals, or alternatively, in bachelor groups that may contain both colts (males) and fillies (females; Penzhorn 1988, Peter Lloyd[1] pers. comm.). Breeding herds are quite stable, with mares usually associated with the herd for life (Joubert 1971 as cited in Skinner and Smithers 1990). Males maintain their status in a breeding herd as long as they are in good physical condition (Skinner & Smithers 1990). Mares may produce their first foals at 3-4 years of age and gestation is 12 months (Joubert 1974). Although under good conditions, they can give birth in consecutive years, females often only produce foals every second year (Saltz 2002).

6.3 Habitat suitability assessment

6.3.1 Platbakkies

The Platbakkies area contained both mountain (i.e., Namaqualand Klipkoppe Shrubland, Kamiesberg Mountain Shrubland, and Namaqualand Granite Renosterveld) and flat grassland (i.e., Bushmanland Arid Grassland, Namaqualand Blomveld, and Platbakkies Succulent Shrubland) habitats. The mountains were mainly restricted to the west (Figure 2), while the central and eastern portions comprised open sandy grasslands (Figure 3). Thus, only a portion (i.e., the mountainous section – *ca*. 6 500 ha) of the area can be considered potentially suitable habitat. Ground surveys indicate that the mountains are largely unvegetated and steep, thus providing limited food, and would be difficult for zebra to traverse. At present, the entire area is comprised of farms and is heavily grazed by domestic livestock (i.e., sheep and goats). These animals would compete directly for food with zebra. Areas that lack domestic herbivores have grass, but these are generally not in good mountainous habitat. The availability of natural surface water is unknown, but few boreholes

[1] Scientific Services - CapeNature, Jonkershoek, Stellenbosch.

are present (Figure 4). Due to the combination of these factors, we recommend that the area is unsuitable for mountain zebra.

Figure 2. The Platbakkies area proved to be unsuitable to mountain zebra. Despite containing both mountain and flat grassland habitats, the mountains were not suitable as they were unvegetated, and too steep and rocky for the zebra to traverse. The flat grassland area is at present heavily utilized by domestic herbivores and thus the availability of grass is low. The availability of natural surface water is unknown.

Figure 3. The central and eastern sections of the Platbakkies area were unsuitable for mountain zebra as they were flat and sandy. At present, these areas contain a large number of farms and thus the availability of grass is low.

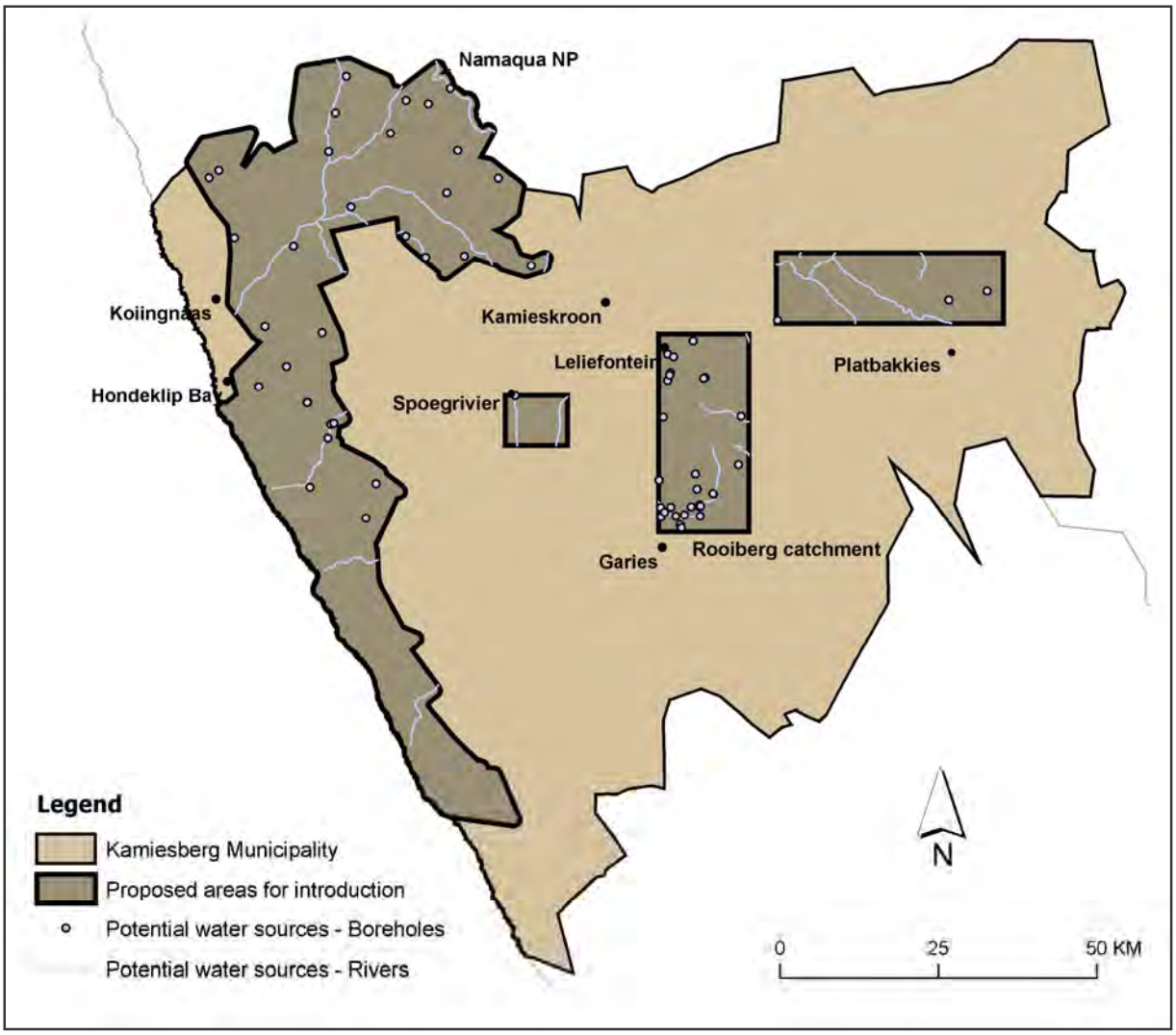

Figure 4. The location of potential water sources in the proposed areas for re-introduction. Although the availability of natural surface water in the area is unknown, there are a large number of artificial water sources. By providing artificial water sources, areas previously unavailable to herbivores, due to a lack of water, may now be utilised, but at risk to the associated biodiversity.

6.3.2 Spoegriver

Around the Spoegriver communal area, the landscape is comprised of mountainous habitat (with Namaqualand Klipkoppe Shrubland) running into deep open valleys (with Namaqualand Heuweltjieveld; Figure 5). Both the mountainous and valley substrates are sandy, with rocky areas restricted to the tops of the peaks.

To the east, around the Tweerivier communal area, there are mountainous areas, dominated by degraded Namaqualand Klipkoppe Shrubland, and open sandy grasslands (with Namaqualand

Blomveld). The area is primarily communal land and has a high density of domestic herbivores (i.e., goats, sheep, cattle and feral donkeys). The overall availability of grazing in the mountains is very low. Human settlements dominate the open areas and grasslands are heavily utilised by domestic herbivores. The only available water is in or around the town of Spoegriver (Figure 4). Because of the low availability of food throughout the different habitats (i.e., Namaqualand Klipkoppe Shrubland, Namaqualand Heuweltjieveld and Namaqualand Blomveld), the low availability of water, competition from domestic herbivores and the sandy mountainous substrate, we recommend that the site is currently unsuitable for mountain zebra. However, if the domestic herbivores are removed and the vegetation rehabilitated, the area could be reassessed for mountain zebra.

Figure 5. Spoegriver contained both mountainous (with Namaqualand Klipkoppe Shrubland) and grassland (with Namaqualand Heuweltjieveld) habitats. At present, these areas contain a large number of domestic herbivores and thus the availability of grass is low. However, if the domestic herbivores are removed the area could be reassessed for mountain zebra.

6.3.3 Rooiberg catchment

The area between Rooiberg, Weeskind and Eselkop forms the main catchment for the Kamiesberg Municipality. The area between and around these three peaks comprises both

communal and privately owned lands. Namaqualand Granite Renosterveld (Figure 6), Kamiesberg Granite Fynbos and Namaqualand Blomveld contributes *ca*. 48 % of the proposed area, while the remaining *ca*. 23 072 ha is a combination of Namaqualand Klipkoppe Shrubland (*ca*. 40 %) and Kamiesberg Mountain Shrubland (*ca*. 12 %; Figure 7). Due to the limited grass that grows within Renosterveld, Fynbos and Blomveld, it is not suitable habitat for mountain zebra. Namaqualand Klipkoppe Shrubland and Kamiesberg Mountain Shrubland, however, do have high availabilities of grass and thus may provide adequate food for mountain zebra. The overall area containing these habitats could potentially be suitable for mountain zebra (Figure 8). It is mountainous but lacks flat open grasslands. The area stretches east-west across the Kamiesberg and thus at times may benefit from both winter and summer rainfall. As zebra can move great distances between feeding areas (Skinner and Smithers 1990) and have been known to respond to rainfall (Penzhorn 1982), they may ultimately start to move seasonally between the summer and winter rainfall areas.

At present, there are a large number of domestic herbivores in the area. Because of this, the availability of grass is low. To increase food availability and thus the suitability for mountain zebra, these animals would need to be removed and the land allowed to recover. As it is the main catchment, natural surface water may be available year round; however, this would need to be confirmed. The area would need to be game fenced to contain the zebra, and exclude domestic herbivores.

Figure 6. In the Rooiberg catchment, Namaqualand Granite Renosterveld contributes *ca*. 35 % of the area. Due to the limited grass that grows within Renosterveld, it is not suitable habitat for mountain zebra.

Figure 7. The portions of the Rooiberg catchment containing Namaqualand Klipkoppe Shrubland could potentially be suitable habitat for mountain zebra. At present, these areas are extensively used by domestic herbivores and thus grass availability is low. Before mountain zebra could be introduced into this area, the domestic herbivores would need to be removed and the land allowed to recover.

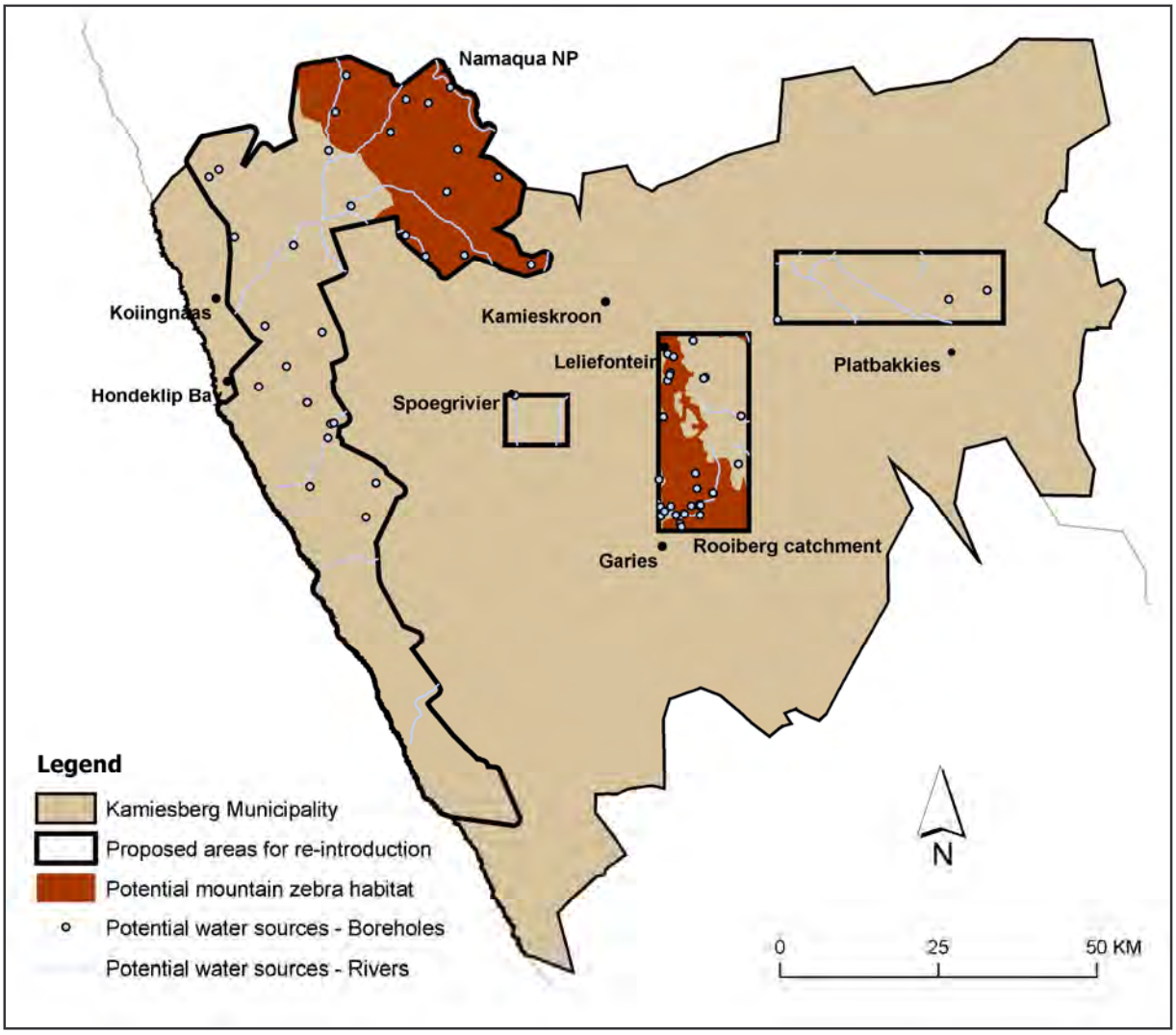

Figure 8: Areas in the Rooiberg catchment (*ca*. 23 072 ha) and Namaqua National Park (*ca*. 71 956 ha) that are potentially suitable for mountain zebra re-introduction.

6.3.4 Namaqua National Park

Portions of the Namaqua National Park are suitable for the re-introduction of mountain zebra. The most appropriate area in the park comprises the mountainous region and an adjacent 5 km wide strip of flat grasslands in the north-eastern portion of the park (Figure 8). This strip contains portions of Namaqualand Klipkoppe Shrubland (58.5 %), Kamiesberg Mountains Shrubland (0.3 %), Namaqualand Arid Grassland (4.4 %) and Namaqualand Heuweltjieveld (36.5 %). There is a high availability of grass in both the mountain (Figure 9) and low grasslands (Figure 10).

Throughout the mountainous habitat, the substrate is sufficiently rocky to wear down the zebra's hooves.

Concerns regarding the suitability of this area are the availability of natural surface water, the potential threat of poaching, and competition with other herbivores. The availability of natural surface water in the park is unknown. There are, however, a large number of artificial water sources (Figure 4). By providing artificial water sources, areas of the park previously unavailable to large herbivores can now be utilised on a year-round basis. This ultimately can lead to extensive degradation to the vegetation in these areas, and artificially inflate the herbivore numbers (Owen-Smith 1996, James *et al*. 1999). Given the demonstrated risks to biodiversity caused by artificial waterpoints in arid and semi-arid landscapes (e.g. James *et al*. 1999) it is recommended that such water sources should not be maintained. At present, poaching occurs along the extensive road network within the northern portion of the park (Giel de Kok[2] pers. comm.). As this is close to areas suitable for mountain zebra, any zebra introduced into the park may be at risk. As bulk grazers, zebra will compete for resources with other herbivores already in the park (e.g., springbok, gemsbok and red hartebeest).

[2] Namaqua National Park, Namaqualand, South Africa

Figure 9. The mountainous regions in the north-eastern portion of Namaqua National Park (comprising Namaqualand Klipkoppe Shrubland and Namaqualand Mountains Shrubland) have a high availability of grass and the substrate is suitably rocky. These factors make the area suitable for the re-introduction of mountain zebra. There are concerns around the potential impacts resulting from the high degree of artificial water sources throughout the park and possible poaching.

Figure 10. In the Namaqua National Park, the sandy flat areas at the base of the mountains (comprising Namaqualand Arid Grassland and Namaqualand Heuweltjieveld) had a high availability of grass. The concern with these areas is the risk of poaching associated with the large number of roads that run through them.

6.4 Summary & Recommendations

Of the four areas assessed, the Rooiberg catchment area and Namaqua National Park were the only two that met the criteria for the re-introduction of mountain zebra (Figure 8). In both these areas, however, there are key issues that need to be addressed prior to re-introduction. At the Rooiberg catchment, four points will need to be addressed:

1. The year-round availability of natural surface water within the proposed area will need to be determined. There are a large number of artificial water sources throughout the region, but only a small number of these are operational at any one time (Giel de Kok pers. comm.). Due to the negative impacts to both animals and vegetation generated by the use of artificial water sources (Owen-Smith 1996, James *et al.* 1999), we recommend not relying on or establishing such sources.
2. Domestic herbivores will need to be removed to reduce competition for food, the risk of disease, as well as potential hybridisation between feral donkeys and mountain zebras.
3. Once the domestic herbivores have been removed, the vegetation will need to be allowed to recover prior to zebra introduction. The duration of this recovery period will vary depending on the rains and the extent to which areas have been overgrazed. A projected minimum would be 2-5 years; however this should be monitored and assessed through expert input.
4. An appropriate game fence will need to be erected around the total area. This will keep the mountain zebra inside and prevent domestic herbivores from utilising available grass.

In Namaqua National Park, our concerns are:

1. Availability of natural surface water, as the establishment of artificial water sources can directly lead to increased herbivore numbers and extensive damage of vegetation.

2. The potential threat of poaching along the extensive road network in the northern portion of the park.
3. The effect of competition on the population sizes of both zebra and other large herbivores (e.g., springbok, gemsbok and red hartebeest) in the park.

6.4.1 Reintroduction strategy

The IUCN Equid Specialist Group has a policy for the establishment of Cape mountain zebra (Novellie *et al.* 2002). As Hartmann's mountain zebra have similar social structure and ecological requirements as Cape mountain zebra, this policy can be applied to both species (Peter Lloyd pers. comm.). Key points include:

1. The establishment of mountain zebra must be within the historical distribution of the species.
2. There must be sufficient infrastructure to provide security and allow monitoring (i.e., adequate fences and roads). As mountain zebra can move over great distances in search of grazing, it is important that potential areas be fenced prior to the introduction of zebra. Suitable game fencing will likely be required, as mountain zebra may get through standard livestock fences (Novellie *et al.* 2002). These fences may also reduce the potential of poaching, but some additional security measures would need to be implemented.
3. The area should preferably not have high agricultural potential, which could affect the future land use to the detriment of the re-introduced population.
4. Habitat quality for the mountain zebras in the proposed area must be high (i.e., not marginal).
5. The amount of good habitat should be sufficient to support at least 100 animals. This, however, will not prevent problems associated with inbreeding depression and genetic drift.

6. The minimum number of individuals used to establish a new population should be 14. This can either be a one to one sex ratio, or slightly skewed in favour of females.
7. The 14 animals should comprise at least three established breeding herds. In addition, it would be best if these herds came from three separate populations (Peter Lloyd pers. comm.).
8. To minimise inbreeding depression and genetic drift, one or two new individuals will need to be acquired and introduced into the population once every five to ten years (i.e., the population should be managed as part of a metapopulation).
9. The re-introduction of mountain zebras should enhance ecotourism in the area.

6.4.2 Potential carrying capacity

Boshoff and Kerley (1999) estimated a wide range of potential stocking rates (ha/zebra) for Cape mountain zebra in the Cape Floristic Region. Unfortunately, their study did not incorporate Namaqualand. In the Cape Floristic Region, potential stocking rates for mountain zebra were as high as 150 ha/zebra. Generally, Namaqualand experiences lower annual rainfall compared to the Cape Floristic Region. Because of these drier conditions, the lack of information on natural waterpoints, and the historically low density of zebra in Namaqualand, we suggest a conservative estimate of at least 200 ha/zebra for Hartmann's mountain zebra in the Kamiesberg. This yields a potential carrying capacity for the Rooiberg catchment (23 072 ha) of 115 individuals, and 359 individuals for Namaqua National Park (71 956 ha). Both areas thus achieve the IUCN recommendation of habitats being able to support a minimum of 100 individuals. However, due to problems associated with inbreeding depression and genetic drift, the populations will require constant monitoring and should be managed as part of a metapopulation.

It is strongly emphasised that these estimates should be treated as hypothetical. We treated the population/area estimates as if all potential forage would be available to mountain zebras. In

situations where other grazers are present (i.e., Namaqua National Park), food resources will be distributed between all herbivores and thus the number of zebras that can be maintained will likely be smaller. An additional consideration is that we are unsure how the introduction of mountain zebra may effect other herbivore populations. Because of this, the population dynamics of both mountain zebras and other herbivore species will need to be monitored, and an adaptive management approach should be adopted.

7. BLACK RHINOCEROS *Diceros bicornis*

7.1 Historical occurrence

Early records indicate that black rhinos lived throughout the Cape Province (du Plessis 1969). However, by the late 18th century, they remained only in the Eastern Cape and north of the Orange River in present day Namibia (Rookmaaker 1989). By 1853, they were gone from the entire Cape Province (Shortridge 1932). There are very few records of black rhino in Namaqualand. William Paterson reported seeing them along the Orange River in 1778 east of Ramansdrift (Skead 1980). In 1779, Robert Gordon reported finding the tracks of a single rhino in northern Namaqualand between what is now Port Nolloth and Alexander Bay (Rookmaaker 1989). Wikar saw fresh rhino spoor in 1779 at Kalagas, which lies just outside of Namaqualand in Kenhardt (Skead 1980). Between 1652 and 1712, black rhinos were recorded along the Olifants River south of Namaqualand (du Plessis 1969).

The subspecies *D. bicornis bicornis* was likely restricted to the Cape Province and southern Namibia (Rookmaaker 1989). As part of a plan to reintroduce the species back into its former range (Hall-Martin 1986), South African National Parks introduced six individuals (*D. bicornis bicornis*) into Augrabies Falls National Park in the Northern Cape in 1985 (Knight *et al.* 1998). These animals have subsequently been removed (M. Landman pers. obs.).

Historical evidence therefore suggests that resident populations of black rhinoceros probably never occurred in Namaqualand. Although it is possible that individuals may have moved through the area from time to time, these movements are likely to have been in response to the seasonal availability of surface water. Moreover, black rhinoceros are sedentary species (Skinner and Smithers 1990) and do not expand their ranges into marginal habitat for long periods. Frequent movements through Namaqualand were therefore unlikely.

Large mammal herbivores, like black rhinoceros, are known to have a significant impact on the structure and composition of plant communities (Owen-Smith 1988). Plant communities that did not support large herbivores for long periods during historical times may be particularly vulnerable to such impacts (e.g. Bond and Loffell 2001). Thus, the introduction and confinement (in a protected area) of black rhinoceros to Namaqualand (a region where they did not occur historically) will likely have a negative impact on the areas unique floral diversity.

7.2 Ecological requirements and general biology

Black rhinoceros occur in a wide range of habitats, but typically prefer undulating habitat with gentle slopes (Joubert and Eloff 1971, Buk 2004, Landman in prep.) and well developed woodlands or thickets (Owen-Smith 1988); open grasslands are generally avoided (Skinner and Smithers 1990, Kotze and Zacharias 1993). During the heat of the day, black rhinoceros may rest in dense thickets, and will use kloofs as shelter from cold winds (Skinner and Smithers 1990).

Black rhinoceros are browsers and dependent on processing large quantities (*ca*. 28-40 kg wet mass/day – Emslie and Adcock 1994, Maddock *et al.* 1995) of forage. They consume a wide variety of plant species (74 species in Etosha NP – Loutit *et al.* 1987, 191 species in Ngorongoro Crater – Goddard 1968), and are flexible, changing their preferences according to the availability of species. Black rhinoceros generally prefer herbaceous plants (Goddard 1970, Mukinya 1973, Oloo *et al.* 1994, Landman in prep.), but become more dependent on woody plants and succulents during the dry season (Hall-Martin *et al.* 1982, Owen-Smith 1988). By pushing over shrubs and trees or sweeping their horns through the foliage, they are able make more food accessible (Joubert and Eloff 1971, Skinner and Smithers 1990). Black rhinoceros may consume 30-60 % of the above ground biomass of plants under 0.5 m in height (Owen-Smith 1988) which, together with the breakage of shrubs and trees, may have a significant impact on the vegetation. The late dry season is usually a critical period for black rhinoceros survival, primarily due to reduced plant growth.

As black rhinoceros tend to drink daily, the availability of water limits their distribution (Joubert and Eloff 1971, Skinner and Smithers 1990). Permanent water sources are not only important for drinking, but also for bathing and mud-wallowing (Skinner and Smithers 1990). Black rhinoceros are seldom found more than 10-15 km from water, but may forage up to a maximum of 25 km from water during the dry season (Kingdon 1979). In areas where black rhinoceros forage on succulent plants they may be able to go without water for longer periods (Joubert and Eloff 1971). In times of the year when surface water is not available, they may dig for it in sandy riverbeds (Skinner and Smithers 1990).

Current conservation status: Black rhinoceros *D. bicornis bicornis* are listed as *Critically Endangered* in the South African Red Data Book (Friedman and Daly 2004), and require special conservation attention

7.3 Habitat suitability assessment

The long-term success of black rhinoceros populations in protected areas requires intensive hands-on management (e.g. increased security, population monitoring and appropriate fencing). Of the four proposed areas, the Namaqua National Park was the best suited to address these management requirements.

7.3.1 Namaqua National Park

As black rhinoceros prefer uneven terrain, the north-eastern portion of the Namaqua National Park provided the most suitable habitat. To the east, the area is characterised by a large stretch of mountainous habitat comprised of Namaqualand Klipkoppe Shrubland and Kamiesberg Mountains Shrubland. The far western portion is characterised by flat grassland habitats, dominated by Namaqualand Heuweltjieveld and Namaqualand Arid Grassland. The mountainous habitat is unsuitable and largely inaccessible to black rhinoceros as the slopes are steep and covered with

large granite boulders (Figure 11). Although these slopes support a variety of small trees and shrubs, the majority of these are dry (or deciduous) during the colder, drier months of the year (typical of Karoo landscapes) and thus are not available to browsers. Succulent plants would be the only available food resource during this period. The flat grassland habitats were unsuitable to black rhinoceros due to limited dry season browse availability. Although a large number of artificial water sources (Figure 4) are available throughout the region, the availability of year-round natural surface water appears to be extremely limited. Due to the profound effects of the use of artificial water sources on landscapes and associated biodiversity (e.g. animal impacts on vegetation and soils in close proximity of waterpoints – Owen-Smith 1996, James *et al*. 1999), we recommend not relying on or establishing them. At present, poaching occurs along the extensive road network within the northern portion of the park (Giel de Kok pers. comm.).

Figure 11. The Namaqua National Park was unsuitable for black rhinoceros. The mountainous habitat towards the north-eastern corner of the Park was generally steep and very rocky. Dry-season browse availability in this area was very low and insufficient to sustain a black rhinoceros population.

7.4 Summary & Recommendations

Given the lack of historical records, the limited area of possibly suitable habitat, the marginal nature of the habitat, the lack of natural, year-round surface water and the risks to biodiversity of using artificial waterpoints to maintain large herbivores, it is not recommended that black rhinoceros should be considered for introduction into the Namaqua National Park. The potential introduction of black rhinoceros into unsuitable habitat in Namaqualand would not contribute towards the species conservation.

8. POTENTIAL FOR OTHER HERBIVORE RE-INTRODUCTIONS

Historically, the Succulent Karoo supported a relatively high diversity of medium- and large sized mammals. These included Sprinbok *Antidorcas marsupialis*, Gemsbok *Oryx gazelle*, Red hartebeest *Alcelaphus buselaphus* and Grey rhebok *Pelea capreolus* (Skead 1980). Unfortunately, most of these species have been extirpated from the region in the last 350 years (Skead 1980). Some areas of Namaqualand may be suitable for the potential re-introduction of these herbivores. This will however require independent habitat suitability assessments.

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