Equus quagga – Plains Zebra

Regional Red List status (2016)	**Least Concern**
National Red List status (2004)	Least Concern
Reasons for change	No change
Global Red List status (2016)	Near Threatened A2a+3c+4ac
TOPS listing (NEMBA)	None
CITES listing	None
Endemic	No

A recent study in Namibia and Botswana described a formerly unknown migration of Plains Zebra from the Chobe River to Nxai Pan National Park. This migration is now suggested to be the longest of all documented migrations by large mammals in Africa (Naidoo et al. 2016).

Taxonomy

Equus quagga (Boddaert 1785)

ANIMALIA - CHORDATA - MAMMALIA - PERISSODACTYLA - EQUIDAE - *Equus* - *quagga*

Synonyms: *Equus burchelli* (Gray 1824) [orth. error]

Common names: Plains Zebra, Burchell's Zebra, Common Zebra, Painted Zebra (English), Bontsebra (Afrikaans), Idube (Ndebele, Zulu), Iqwarhashe (Xhosa)

Taxonomic status: Species

Taxonomic notes: Groves and Bell (2004) described six subspecies of *Equus quagga* based on craniometric taxonomic methods, which showed all subspecies to be alike, and distinctly different from Mountain Zebras (*Equus zebra*). The six subspecies differ from one another in morphological characteristics, such as coat patterns and colouration, body size, and the presence (or absence) of a mane (Groves & Bell 2004). Although there is limited evidence for genetic diversity between subspecies and the classification may be a contested topic (Bennett 1980), a classification of subspecies can be useful as a way to emphasise ecological and morphological differences for management purposes. Following Groves and Bell (2004), six morphologically defined subspecies are listed as:

- *Equus q. crawshaii* (Crawshay's Zebra) occurs in east Zambia, east of Luangwa River, Malawi, south-eastern Tanzania, and Mozambique as far south as the Gorongoza district.
- *Equus q. borensis* (Maneless Zebra) ranges over the northern parts of east Africa from north-west Kenya to the Karamoja district of Uganda and south-east Sudan, east of the Nile River (Boma National Park) to the northern limit of the species' range (32 °N).
- *Equus q. boehmi* (Grant's Zebra or Boehm's Zebra) is found in Zambia, west of the Luangwa River, west to Kariba, the Shaba Province of the Democratic Republic of the Congo north to Kibanzao Plateau, Tanzania north from Nyangaui abnd Kibwezi into south-west Uganda, south-west Kenya, and east Kenya, east of the Rift Valley, into southern Ethiopia and perhaps to the Juba River in Somalia. This subspecies constitutes of over 75% of Africa's Plain Zebra population, and the Serengeti-Mara ecosystem supports approximately 200,000 individuals (East 1997; Hack et al. 2002).
- *Equus q. chapmani* (Chapman's Zebra) ranges from north-east South Africa, from about 24 °S, 31 °E, north to Zimbabwe, west into Botswana at about 19 °S, 24 °E, across the Caprivi Strip in Namibia, and into southern Angola.
- *Equus q. burchellii* (Burchell's Zebra) formally occurred north of the Vaal/Orange Rivers, extending north-west via Botswana to Etosha National Park and the Kaokoveld, south-east to KwaZulu-Natal and Swaziland. It is now extinct in the middle of its range. *Equus. q. antiquorum* is now included in this subspecies.
- *Equus q. quagga* (Cape Quagga) occurred in the former Cape Province, south of the Orange and Vaal Rivers and west of the Drakensberg. This subspecies has been extinct since 1883.

Research indicates that the extinct *E. q. quagga* might differ morphologically from other Plains Zebra subspecies, but those differences are not sufficient to justify its classification as an independent species. Thus the extinct *E. q. quagga* should be considered a subspecies of *E. quagga.* From north to south of their geographic range, extant Plains Zebras show a gradual decline in the contrast between dark stripes and white interspaces, and an increase in body size is noted from east to south (Lorenzen et al. 2008). The extinct Cape Quagga, which was found at the southern limit of the species' geographic range, exhibited the extreme case of this trend in pelage colouration (Groves & Bell 2004; Lorenzen et al. 2008).

Assessment Rationale

Plains Zebras are listed as Least Concern because they are widespread and abundant throughout the assessment

Recommended citation: Stears K, Shrader A, Castley G. 2016. A conservation assessment of *Equus quagga*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

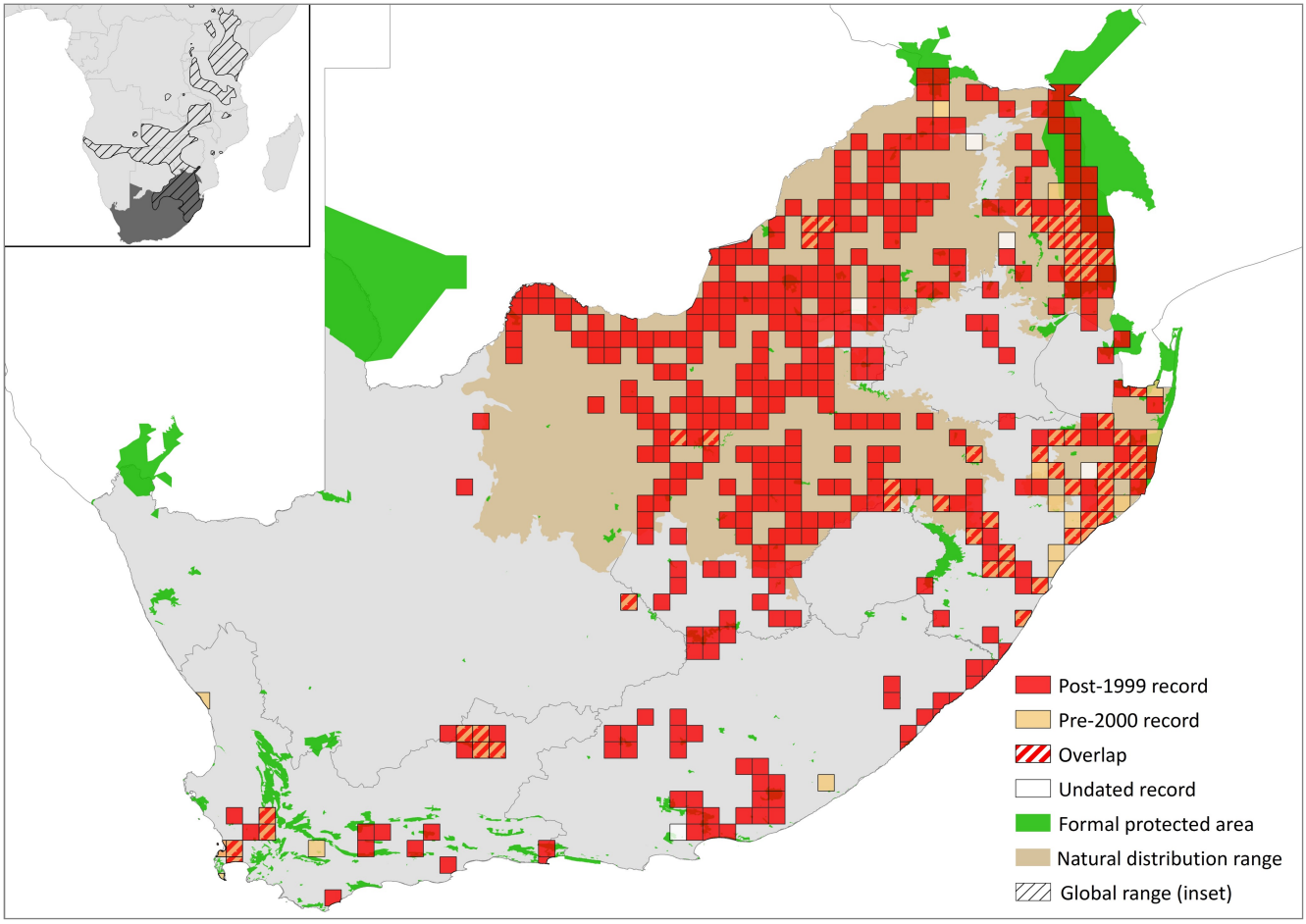

Figure 1. Distribution records for Plains Zebra (*Equus quagga*) within the assessment region

Table 1. Countries of occurrence within southern Africa

Country	Presence	Origin
Botswana	Extant	Native
Lesotho	Extinct	Native
Mozambique	Extant	Native
Namibia	Extant	Native
South Africa	Extant	Native
Swaziland	Extant	Native
Zimbabwe	Extant	Native

region and, at present, there are no major threats affecting the population. Within South African National Parks alone, there are an estimated 31,948–46,237 individuals (counts conducted from 2010–2012), with Kruger National Park (KNP) containing the bulk of the population (29,161–43,450 individuals). The expansion of wildlife ranches across the country is also increasing the abundance of this species. The only real threat to this species is the fragmentation of its habitat, being restricted to fenced areas, which increases its risk to drought and other disturbances. Continued protected area expansion through transfrontier conservation areas, conservancies and stewardship schemes should be employed to enhance free movement of Plains Zebra in response to climatic variability, and changes in the availability of forage and water.

Regional population effects: Within the assessment region, migration does take place within transfrontier parks, such as KNP and the Greater Mapungubwe Transfrontier Conservation Area (TFCA), however the remaining population is typically restricted to private, provincial and national protected areas. A degree of genetic dispersal occurs through the translocation of individuals between these protected areas via game sales. No rescue effects are necessary.

Distribution

This species ranges from the northern region of South Africa northwards to southern Sudan and Ethiopia, and westwards into northern Namibia and southern Angola (Hack et al. 2002). Historically, Plains Zebra exhibited a much broader range across the African continent, and fossil remains have been discovered from North Africa (Churcher & Richardson 1978). More recently, Plains Zebra ranged throughout eastern and southern Africa, with only the exception of the forest belts of Uganda (Duncan 1992), and extended southwards across the Orange and Vaal Rivers in South Africa to the Cape, with the subspecies *E. q. quagga*, which is now extinct (Groves & Bell 2004). The species is also now extinct in Burundi and Lesotho, and there remains a question over their presence in Angola.

Within the assessment region, the natural range of the Plains Zebra is found in the eastern Lowveld and the KwaZulu-Natal lowlands, and into the Northern Cape (Figure 1). Subpopulations have been widely reintroduced across their natural range, for example, in North West Province where they once occurred throughout the province (du Plessis 1969; Rautenbach 1982; Power 2014). A migratory subpopulation exists in the KNP;

however, most other populations do not have sufficient area in which to migrate seasonally. Subpopulations of the species have been introduced into areas outside of its natural range (Figure 1). The Greater Mapungubwe Transfrontier Conservation Area (between South Africa, Botswana and Zimbabwe) also supports a subpopulation, and approximately 300 individuals are within the Botswana section.

Population

The Plains Zebra is common, widespread and amongst the most abundant of all grazing mammals in Africa, with a total population size of 663,212 individuals estimated in 2002 (Hack et al. 2002). Recent information regarding global overall population numbers is limited. However, during the previous decades, this species has been extirpated from portions of its range (Hack et al. 2002). Within the assessment region, the population is increasing, both on formally protected areas and the expansion of private wildlife ranches. For example, the subpopulation on Golden Gates Highlands National Park, Free State Province, has increased from 131 to 1,592 individuals between 1994 and 2016 (Bissett et al. 2016). Similarly, on Chelmsford Nature Reserve, KwaZulu-Natal Province, the Plains Zebra population has increased from 97 to 876 individuals between 1986 and 2014 (KwaZulu-Natal Ezemvelo Wildlife unpubl. data). The generation length of the Plains Zebra has been calculated as 10 years (Pacifici et al. 2013), which makes the three generation window 30 years (1986–2016). While few long-term datasets area available to quantify the overall national population increase, nearly all protected areas show an increasing or stable trend.

Within South African National Parks, there are an estimated 31,948–46,237 (seven protected areas; 2010–2012 counts) individuals (Ferreira et al. 2013), with KNP containing the bulk of the population (29,161–43,450 individuals, estimated using distance sampling in 2012). Overall, there is a minimum estimate of 59,204 individuals on 803 protected areas and wildlife ranches across the country (2010–2015 counts; Endangered Wildlife Trust unpubl. data), which equates to 35,522–41,443 mature individuals assuming a 60–70% mature population structure. Thus, the wild population is well established and appears to be increasing. There are three main groups:

1. **Kruger National Park and the Associated Private Nature Reserves:** The KNP is estimated to contain around 54–78% of the total the free-roaming population.
2. **Northern KwaZulu-Natal:** The Plains Zebra population was estimated to comprise 12,166 individuals. However, these data do not represent the entire population within the province as they are limited to 22 Ezemvelo-KZN Wildlife protected areas and 31 private reserves. As a result, this value better represents a minimum population estimate.
3. **Limpopo, North West, and Northern Cape provinces**: Large numbers in private populations through the region. The North West alone, for example, contains 4,450 individuals on provincial reserves and 8,920 individuals on private properties (Power 2014).

Population density ranges from estimates of 22 animals / km^2 in Ngorongoro (Klingel 1969), 16.6 animals / km^2 in Nechisar National Park, Ethiopia (Doku et al. 2007), to 0.9 animals / km^2 in KNP (Smuts 1976). Densities are also expected to vary seasonally in migratory regions, as not all individuals migrate (Hack et al. 2012).

Current population trend: Increasing

Continuing decline in mature individuals: No

Number of mature individuals in population: 35,522–41,443

Number of mature individuals in largest subpopulation: 17,497–30,415 animals in KNP.

Number of subpopulations: At least 97 in formally protected areas.

Severely fragmented: Yes, with the exception of Greater Limpopo Transfrontier Park and Mapungubwe Transfrontier Conservation Area, all reserves are fenced, and do not allow for natural movements and migrations. Translocations of individuals do contribute towards gene flow.

Habitats and Ecology

With the exception of a few extreme environments, such as deserts, dune forests and rain forests, Plains Zebra thrive across a broad range of habitats in Africa within both tropical and temperate climates (Duncan 1992; Hack et al. 2002; Stuart & Stuart 2007). From sea level to elevations of 4,300 m on Mount Kenya, Plains Zebra utilise open grasslands, as well as savanna woodland (Duncan 1992). In southern Ethiopia, Plains Zebra revealed a distinct preference for open grassland habitats, and habitat preference showed seasonal variability (Regassa & Yirga 2013). The dietary flexibility and its tolerance for highly fibrous grass material are the factors considered to contribute to the Plains Zebra's broad geographic range (Schulz & Kaiser 2013).

Sward height largely affects Plains Zebra feeding patterns and, in northern Botswana, once grass height had declined to 20 cm, they moved off in pursuit of taller grasses (Joos-Vandewalle 2000). In the Hluhluwe-iMfolozi Park Zebra foraged on a range of grasses, but again, in grazing lawns of *Digitaria argyograpta*, *Urochloa mosambicensis* and *Sporobolus nitens*, they limited their grazing to grass swards with a height of at least 20 cm (Arsenault & Owen-Smith 2008). Within medium-tall bunch-grasslands comprised of *Themeda triandra*, *Cymbopogon plurinodis* and *Heteropogon contortus*, they selected for grass swards at least 10 cm tall (Arsenault & Owen-Smith 2008). The availability of water directly influences their movements and habitat selection (Estes 1991; Duncan 1992; Skinner & Chimimba 2005). A migratory subpopulation in Tanzania congregates in the Serengeti Plains during the rainy season (November to May), but migrates north-westwards during the dry season, and into Kenya's Maasai-Mara National Reserve (Hack et al. 2002). A recent study in Namibia and Botswana described a formerly unknown migration of *Equus quagga* from the Chobe River (border of Botswana and Namibia) to Nxai Pan National Park (Botswana) (Naidoo et al. 2016). The round-trip migration covers a straight-line distance of 500 km, which is longer than the seasonal migratory movement of Blue Wildebeest (*Connochaetes taurinus)* from the Serengeti to the Maasai-Mara in East Africa (Naidoo et al. 2016). In fact, Naidoo et al. (2016) suggest that this is the longest of all documented migrations by large mammals in Africa. Within the assessment region, fences surrounding protected areas predominantly inhibit

the migration of the Plains Zebra, with the exception of Greater Limpopo Transfrontier Park and Mapungubwe Transfrontier Conservation Area between Botswana, South Africa and Zimbabwe.

Plains Zebra are gregarious and highly social, forming herds comprised of one dominant stallion, several females and their offspring (Klingel 1969). Males without harems form unstable bachelor herds of up to 50 individuals or remain solitary (Klingel 1969; Hack et al. 2002). Breeding in the Plains Zebra is not considered seasonal, as young are born throughout the year (Klingel 1969), however, a peak in births occurs between December and January, and the vast majority of foals are born during the summer months (Smuts 1976).

Ecosystem and cultural services: As hindgut fermenters, Plains Zebra process their food at a faster rate than ruminants. To compensate, they eat more bulk, including vegetation that is too fibrous and low in protein for most ruminants to digest effectively. Resultantly, they have the ability to survive on poor quality vegetation providing it is abundant. Additionally, Zebra have a low relative muzzle width index, better suited for foraging in taller grass (Arsenault & Owen-Smith 2008). By feeding on taller grass they can facilitate the grazing of other herbivores that require shorter grazing grass.

Plains Zebra have aided livestock farmers in reducing the predation pressure of dogs and jackals on livestock calves, because Zebra chase and deter these predators. Thus, farmers keep small herds of Zebras on their properties for this reason (K. Stears, unpublished data).

Finally, as a highly charismatic and extremely visible species, the Plains Zebra is a powerful attraction for ecotourism and a valuable species for international support of wildlife and ecosystem conservation.

Use and Trade

Plains Zebra is popular amongst both subsistence and commercial hunters for skins, meat and trophies. They were one of the top three most exported animal trophies in Namibia in 2012 (Di Minin et al. 2016). Live animals are frequently traded at game auctions. Trade and hunting of this species is not expected to have a severely negative impact on the population. However, the wildlife ranching industry may be artificially selecting individuals to produce desired colour morphs and/or hybridising native with exotic subspecies. Although this is not expected to impact the wild population, regulations should be established to prevent such individuals from entering formally protected areas. A worrying trend is the increasing intensity of bushmeat hunting in southern Africa (Lindsey et al. 2013), including some areas within the assessment region (Hayward 2009; Nel 2015). Presently, however, these reductions are localised and are unlikely to have an effect on the overall population.

Threats

Across much of eastern Africa, habitat encroachment by cattle threatens the forage quality and quantity of Plains Zebra while illegal hunting can cause local declines (Hofer et al. 1996; Grange et al. 2004, 2015; Regassa & Yirga 2013). As a result, Regassa and Yira (2013) suggested the implementation of effective management policies to combat illegal settlements and encroachment by humans in the Yabello Wildlife Sanctuary of southern Ethiopia. Within the assessment region, this species is mostly restricted to protected areas; therefore, these threats are unlikely to become a major problem, although localised problems with poaching do occur in protected areas, such as in Borakalalo Nature Reserve, North West Province (Nel 2015). Constrained movements do, however, increase the species' vulnerability to drought (Walker et al. 1987; Georgiadis et al. 2003). This is particularly true within biomes most at risk to the effects of climate change, water scarcity and enhanced aridity. Subpopulations have

Table 2. Use and trade summary for the Plains Zebra (*Equus quagga*)

Category	Applicable?	Rationale	Proportion of total harvest	Trend
Subsistence use	Yes	Bushmeat trade.	Unknown	Stable
Commercial use	Yes	Trade in skins and trophies. Non-consumptive ecotourism on provincial and private reserve.	Unknown	Stable
Harvest from wild population	Yes	Live animal sales.	Unknown	Stable
Harvest from ranched population	Yes	Meat, skins and trophies.	10–15% per annum (Hack et al. 2002)	Increasing with wildlife ranching expansion.
Harvest from captive population	Yes	Captive breeding for skins. This is rare for this species because it is mostly focused on Mountain Zebra species, *E. z. zebra* and *E. z. hartmannae*. However, there is an increasing trend to intensively breed for colour morphs in captivity.	Unknown	Increasing with wildlife ranching expansion.

Table 3. Possible net effects of wildlife ranching on the Plains Zebra (*Equus quagga*) and subsequent management recommendations

Net effect	Unknown
Data quality	Suspected
Rationale	The overall population size and geographic range of Plains Zebra has been increased significantly through the practices of wildlife ranching. However, the effects of genetic manipulation, sexually-skewed hunting pressure and the spread of diseases threaten to impact on overall populations.
Management recommendation	Research into the effects of management practices on Plains Zebra kept on private properties is required.

shown increases and declines associated with high and low rainfall years, respectively (Gandiwa et al. 2016). Nonetheless, following population declines associated with drought years, Plains Zebra subpopulations have demonstrated fairly rapid recoveries in population abundance to levels above those prior to the drought (Hack et al. 2002). Thus, when provided with adequate habitat and protection from overhunting, the Plains Zebra is recognised as a relatively resilient species.

Equus q. antiquarum, previously considered a distinct subspecies, is currently included under the subspecies *E. q. burchelli* (Groves & Bell 2004). Occurring in a few isolated subpopulations in protected areas of KwaZulu-Natal, these subpopulations have been considered under threat from population isolation, and possibly the detrimental results of inbreeding (Bowland et al. 2001). Bowland et al. (2001) recognises the importance of improving management practices and the active translocation of small, isolated populations between

Table 4. Threats to the Plains Zebra (*Equus quagga*) ranked in order of severity with corresponding evidence (based on IUCN threat categories, with regional context)

Rank	Threat description	Evidence in the scientific literature	Data quality	Scale of study	Current trend
1	*2.1.3 Agro-industry Farming*: loss of habitat from agricultural expansions. Current stresses *1.2 Ecosystem Degradation*, *1.3 Indirect Ecosystem Effects* and *2.3.5 Inbreeding*: habitat degradation and increased vulnerability to drought through fragmentation of habitat; inbreeding in small fenced reserves.	Walker et al. 1987	Empirical	Local	Increasing due to climate change and ongoing agricultural expansion.
		Bowland et al. 2001	Empirical	Regional	
		Georgiadis et al. 2003	Indirect	Local	
		Gandiwa et al. 2016	Empirical	Local	
2	*2.3.3 Agro-industry Grazing, Ranching or Farming*: loss of habitat from ranching expansions. Current stresses *1.2 Ecosystem Degradation*, *1.3 Indirect Ecosystem Effects* and *2.3.5 Inbreeding*: habitat degradation from overgrazing and increased vulnerability to drought through fragmentation of habitat; inbreeding in small fenced reserves.	Walker et al. 1987	Empirical	Local	Increasing due to climate change and ongoing agricultural expansion.
		Bowland et al. 2001	Empirical	Regional	
		Georgiadis et al. 2003	Indirect	Local	
		Gandiwa et al. 2016	Empirical	Local	
3	*1.1 Housing & Urban Areas*: loss of habitat from human settlement expansion. Current stresses *1.3 Indirect Ecosystem Effects*, *2.1 Species Mortality* and *2.3.5 Inbreeding*: increased vulnerability to drought through fragmentation of habitat and increased levels of poaching; inbreeding in small fenced reserves.	Walker et al. 1987	Empirical	Local	Increasing due to climate change and continuing expansion of human settlements.
		Bowland et al. 2001	Empirical	Regional	
		Georgiadis et al. 2003	Indirect	Local	
		Nel 2015	Empirical	Local	
		Gandiwa et al. 2016	Empirical	Local	
4	*2.3.2 Small-holder Grazing, Ranching or Farming*: loss of habitat from small-holder ranching. Current stresses *1.2 Ecosystem Degradation*, *1.3 Indirect Ecosystem Effects*, *2.3.1 Hybridisation* and *2.3.5 Inbreeding*: habitat degradation from overgrazing and increased vulnerability to drought through fragmentation of habitat; inbreeding in small fenced reserves; hybridisation and decreased genetic diversity in small subpopulations (< 100 zebra) on wildlife ranches.	Walker et al. 1987	Empirical	Local	Increasing due to climate change and expansion of wildlife ranches.
		Bowland et al. 2001	Empirical	Regional	
		Georgiadis et al. 2003	Indirect	Local	
		Gandiwa et al. 2016	Empirical	Local	
5	*8.1.1 Invasive Non-Native/Alien Species/ Diseases*: spread of pathogens and parasites through translocations into new areas and/or mixing subspecies.	-	Anecdotal	-	Possibly increasing through expansion of wildlife ranching and translocations.

protected areas in order to sustain genetic diversity and population viability. On the other hand, an important consideration is that the expansion of the species' range through translocation could introduce new pathogens and parasites to populations without co-evolved resistance to them (Hack et al. 2002). Plains Zebra occur across a range of habitats, and it is probable that they have distinct adaptations to local conditions (Hack et al. 2002). Expanding its range through translocation from ecologically diverse regions may result in a decline in these particular adaptations. Consequently, the spatial scale, ecological conditions, genetics and resistance to diseases need to be considered before translocations occur. Similarly, while wildlife ranching is considered largely beneficial for Plains Zebra conservation in South Africa, and has effectively increased the extent and abundance of the species, some concern exists over the genetic implications of selective breeding for particular colour morphs and outbreeding depression caused by mixing subspecies. Further research is required to quantify this potential threat.

Current habitat trend: Stable. Savannah habitat is not threatened within the assessment region (Driver et al. 2012). Habitat available to Plains Zebras has increased through an increase in transfrontier conservation areas, privately owned reserves, and the expansion of wildlife ranching. However, there is some loss in habitat quality through agriculture and livestock farming. Grassland biomes form key habitat for Zebra, and is one of South Africa's most threatened ecosystems with only ~2.4% being formally conserved (Carbutt & Martindale 2014).

Conservation

Within the assessment region, Plains Zebra occur in numerous well-managed protected areas, where KNP and its surrounding reserves protect the core free-roaming population. The majority of the reserves surrounding KNP are not fenced and allow for unrestricted movement of Plains Zebra and consequently, enhanced genetic diversity. KNP also forms part of the Greater Limpopo Transfrontier Park which allows movement over a much larger scale. The Greater Mapungubwe TFCA also allows unrestricted Plains Zebra migration between Botswana, South Africa and Zimbabwe. Continued expansion of transfrontier conservation areas will enable this species to adapt to changing climates and environments and thus enhance the resilience of the population (for example, Bartlam-Brooks et al. 2011).

While no specific interventions are required at present, Hack et al. (2002) recommended the following conservation strategies for Plains Zebra that are relevant for the assessment region:

1. Improve coverage and frequency of monitoring. Annual or biennial sampling of population abundance, location and conservation status is required in order to detect problems in their primary stages and respond effectively. This is particularly relevant for private protected areas and wildlife ranches to gather baseline information needed to develop a Biodiversity Management Plan and translocation policy.
2. Improve risk assessment. A detailed and local investigation into site- and subpopulation-specific hazards, particularly with regards to mitigating potential inbreeding, hybridisation and disease transmission on small fenced properties, is necessary.
3. Quantify and manage genetic diversity, both globally and locally. Management plans may need to be specifically reviewed and implemented for genetically distinct populations.
4. Investigate the economics of alternative utilisation strategies. Quantifying and comparing the economic uses of this species may guide future global management strategies, and incentivise landowners to further reintroduce subpopulations within the natural range of the species.

Recommendations for land managers and practitioners:

- Improve management of small subpopulations to prevent inbreeding and a loss of genetic diversity. This can be achieved through the development of a Biodiversity Management Plan and associated translocation policy. For the latter, a harem should be translocated every 5 years for a subpopulation size of *c.* 9 individuals, while for a population size of *c.*110 individuals, translocations should take place every 15 years if heterozygosity is to be maintained at more than 90% within each subpopulation over 100 years (Bowland et al. 2001).
- Remove fences to create conservancies, which allow for an increase in free-roaming subpopulations.

Table 5. Conservation interventions for the Plains Zebra (*Equus quagga*) ranked in order of effectiveness with corresponding evidence (based on IUCN action categories, with regional context)

Rank	Intervention description	Evidence in the scientific literature	Data quality	Scale of evidence	Demonstrated impact	Current conservation projects
1	*1.1 Site/Area Protection*: expand transfrontier areas to create corridors for migration and adaptation.	Bartlam-Brooks et al. 2011	Empirical	Regional	Migration route restored after creation of corridor.	Peace Parks Foundation
2	*3.3.1 Species Reintroduction*: translocations of harems in small intensively managed populations to increase genetic diversity, possibly through metapopulation strategy.	-	Anecdotal	-	-	-
3	*4.3 Awareness & Communications*: inform game farmers and the hunting industry on dangers of selective breeding and inbreeding.	-	Anecdotal	-	-	-

- Maintain accurate abundance, distribution and population structure records.
- The management of artificial waterholes plays a vital role in the population dynamics of this species. The spatial distribution of active waterpoints should vary temporally. This will create variation in habitat use and movements across the landscape, thereby sustaining landscape heterogeneity.

Research priorities:

- Investigating the effects of wildlife ranching, including factors associated with sexually-skewed hunting pressure and the corresponding influence on female reproduction success. It is suggested that high turnover rates of dominant, harem males can negatively influence female body condition and hormone fluctuations (Berger 1983). Research is necessary to determine whether this is the case for Plains Zebras.
- Studies into the factors regulating natural population fluctuations of Plains Zebra would aid in predicting their responses to human-induced changes to their habitats.
- Examining the spread of pathogens and parasites via harem translocations into new areas.

Encouraged citizen actions:

- Citizens can refuse to hunt artificial colour morphs and hybrids.
- Landowners could remove fences and create conservancies and corridors for this species, encouraging natural migrations and movements.
- Subpopulations outside of the species' natural distribution (for example, Western Cape Province) could be removed.
- Private landowners, provincial and national reserves can contribute data on subpopulation numbers and structures to virtual museum platforms (for example, iSpot and MammalMAP) to ensure accurate assessments of species through the Red Listing process.

Data Sources and Quality

Table 6. Information and interpretation qualifiers for the Plains Zebra (*Equus quagga*) assessment

Data sources	Field study (unpublished)
Data quality (max)	Estimated
Data quality (min)	Estimated
Uncertainty resolution	Best estimate
Risk tolerance	Evidentiary

References

Arsenault R, Owen-Smith N. 2008. Resource partitioning by grass height among grazing ungulates does not follow body size relation. Oikos **117**:1711–1717.

Bartlam-Brooks HLA, Bonyongo MC, Harris S. 2011. Will reconnecting ecosystems allow long-distance mammal migrations to resume? A case study of a zebra *Equus burchelli* migration in Botswana. Oryx **45**:210–216.

Bennett DK. 1980. Stripes do not a zebra make, Part I: A cladistic analysis of *Equus*. Systematic Biology **29**:272–287.

Berger J. 1983. Induced abortion and social factors in wild horses. Nature **303**:59–61.

Bissett C, Ferreira S, Bezuidenhout H, Smit I, Daemane E, Mokoena V, Sikhosana T. 2016. Golden Gate Highlands National Park herbivore off-take recommendations 2016: An integrated approach combining local knowledge with data derived from animal census, herbivore models, vegetation field monitoring and satellite imagery. Internal Report 09 / 2016, Scientific Services, South African National Parks, South Africa.

Bowland AE, Bishop KS, Taylor PJ, Lamb J, van der Bank FH, van Wyk E, York D. 2001. Estimation and management of genetic diversity in small populations of plains zebra (*Equus quagga*) in KwaZulu-Natal, South Africa. Biochemical Systematics and Ecology **29**:563–583.

Carbutt C, Martindale G. 2014. Temperate indigenous grassland gains in South Africa: Lessons being learned in a developing country. PARKS **20**:101–121.

Churcher C, Richardson M. 1978. Equidae. Pages 379–422 in Maglio V, Cooke H, editors. Evolution of African Mammals. Harvard University Press, Cambridge, USA.

Di Minin E, Leader-Williams N, Bradshaw CJ. 2016. Banning trophy hunting will exacerbate biodiversity loss. Trends in Ecology & Evolution **31**:99–102.

Doku Y, Bekele A, Balakrishnan M. 2007. Population status of plains zebra (*Equus quagga*) in Nechisar plains, Nechisar National Park, Ethiopia. Tropical Ecology **48**:79–86.

Driver A, Sink KJ, Nel JN, Holness S, Van Niekerk L, Daniels F, Jonas Z, Majiedt PA, Harris L, Maze K. 2012. National Biodiversity Assessment 2011: An Assessment of South Africa's Biodiversity and Ecosystems. Synthesis Report. South African National Biodiversity Institute and Department of Environmental Affairs, Pretoria, South Africa.

du Plessis SF. 1969. The past and present distribution of the Perissodactyla and Artiodactyla in southern Africa. M.Sc. Thesis. University of Pretoria, Pretoria, South Africa.

Duncan P. 1992. Zebras, Asses and Horses: an Action Plan for the Conservation of Wild Equids. IUCN, Gland, Switzerland & Cambridge, UK.

East R. 1997. Current status of Burchell's Zebra in Africa, with additional information on Grevy's Zebra and Cape Mountain Zebra. IUCN SSC Equid Specialist Group.

Estes R. 1991. The Behaviour Guide to African Mammals. University of California Press, Berkeley, USA.

Ferreira S, Gaylard A, Greaver C, Hayes J, Cowell C, Ellis G. 2013. Animal abundances in Parks 2012/2013. Scientific Services, SANParks, Skukuza, South Africa.

Gandiwa E, Heitkönig IM, Eilers PH, Prins HH. 2016. Rainfall variability and its impact on large mammal populations in a complex of semi-arid African savanna protected areas. Tropical Ecology **57**:163–180.

Georgiadis N, Hack M, Turpin K. 2003. The influence of rainfall on zebra population dynamics: implications for management. Journal of Applied Ecology **40**:125–136.

Grange S, Barnier F, Duncan P, Gaillard J-M, Valeix M, Ncube H, Périquet S, Fritz H. 2015. Demography of plains zebras (*Equus quagga*) under heavy predation. Population Ecology **57**:201–214.

Grange S, Duncan P, Gaillard J-M, Sinclair AR, Gogan PJ, Packer C, Hofer H, East M. 2004. What limits the Serengeti zebra population? Oecologia **140**:523–532.

Groves CP, Bell CH. 2004. New investigations on the taxonomy of the zebras genus *Equus*, subgenus *Hippotigris*. Mammalian Biology **69**:182–196.

Hack AM, East R, Rubenstein DI. 2002. Status and Action Plan for the Plains Zebra. Pages 43–60 in Moehlman PD, editor. Equids: Zebras, Asses and Horses. Status Survey and Conservation Action Plan. IUCN, Gland, Switzerland.

Hayward MW. 2009. Bushmeat hunting in Dwesa and Cwebe Nature Reserves, Eastern Cape, South Africa. South African Journal of Wildlife Research **39**:70–84.

Hofer H, Campbell KLI, East ML, Huish SA. 1996. The impact of game meat hunting on target and non-target species in the Serengeti. Pages 117–146 in Taylor VJ, Dunstone N, editors. The Exploitation of Mammal Populations. Chapman and Hall, London, UK.

Joos-Vandewalle ME. 2000. Movement of migratory zebra in northern Botswana. Ph.D. Thesis. University of the Witwatersrand, Johannesburg, South Africa.

Klingel H. 1969. The social organisation and population ecology of the plains zebra (*Equus quagga*). Zoologica Africana **4**:249–263.

Lindsey PA et al. 2013. The bushmeat trade in African savannas: Impacts, drivers, and possible solutions. Biological Conservation **160**:80–96.

Lorenzen ED, Arctander P, Siegismund HR. 2008. High variation and very low differentiation in wide ranging plains zebra (*Equus quagga*): insights from mtDNA and microsatellites. Molecular ecology **17**:2812–2824.

Naidoo R, Chase MJ, Beytell P, du Preez P, Landen K, Stuart-Hill G, Taylor R. 2016. A newly discovered wildlife migration in Namibia and Botswana is the longest in Africa. Oryx **50**:138–146.

Nel P. 2015. Population estimates for large herbivores and predators in protected areas in the North West Parks Board November 2015. North West Parks Board. Mahikeng, South Africa.

Pacifici M, Santini L, Di Marco M, Baisero D, Francucci L, Marasini GG, Visconti P, Rondinini C. 2013. Generation length for mammals. Nature Conservation **5**:89–94.

Power RJ. 2014. The Distribution and Status of Mammals in the North West Province. Department of Economic Development, Environment, Conservation & Tourism, North West Provincial Government, Mahikeng, South Africa.

Rautenbach IL. 1982. Mammals of the Transvaal. No. 1, Ecoplan Monograph. Pretoria, South Africa.

Regassa R, Yirga S. 2013. Distribution, abundance and population status of Burchells zebra (*Equus quagga*) in Yabello Wildlife Sanctuary, Southern Ethiopia. Journal of Ecology and the Natural Environment **5**:40–49.

Schulz E, Kaiser TM. 2013. Historical distribution, habitat requirements and feeding ecology of the genus *Equus* (Perissodactyla). Mammal Review **43**:111–123.

Skinner JD, Chimimba CT. 2005. The Mammals of the Southern African Subregion. Third edition. Cambridge University Press, Cambridge, UK.

Smuts GL. 1976. Population characteristics of Burchell's zebra (*Equus burchelli antiquorum*, H. Smith, 1841) in the Kruger National Park. South African Journal of Wildlife Research **6**:99–112.

Stuart CT, Stuart MD. 2007. Field Guide to Mammals of Southern Africa. Random House Struik (Pty) Ltd, Cape Town, South Africa.

Walker BH, Emslie RH, Owen-Smith RN, Scholes RJ. 1987. To cull or not to cull: lessons from a southern African drought. Journal of Applied Ecology **24**:381–401.

Assessors and Reviewers

Keenan Stears[1], Adrian Shrader[1], Guy Castley[2]

[1]University of KwaZulu-Natal, [2]Griffith University

Contributors

Claire Relton[1], Matthew F. Child[1], Patricia Moehlman[2,†], Jeanetta Selier[3], Sarah King[2]

[1]Endangered Wildlife Trust, [2]EcoHealth Alliance, [3]South African National Biodiversity Institute

[†]IUCN SSC Equid Specialist Group

Details of the methods used to make this assessment can be found in *Mammal Red List 2016: Introduction and Methodology.*