

Population status of plains zebra (*Equus quagga*) in Nechisar plains, Nechisar National Park, Ethiopia

YISEHAK DOKU, AFEWORK BEKELE & M. BALAKRISHNAN*

Department of Biology, Addis Ababa University, P.O. Box 1176, Addis Ababa, Ethiopia

Abstract: The population status, structure, abundance and trend of plains zebra (*Equus quagga*) were studied in Nechisar plains, Nechisar National Park, southern Ethiopia, using transects and silent detection methods. The population of plains zebra in the area was estimated at 4500, with the population density of 16.6 km⁻². The average herd sizes of one-male harem and bachelor stallion herds were 10.8 and 6.4, respectively. Adult males constituted 34.8%, adult females 41.5% and unsexed young 23.7%. Male:female ratio was 1.00:1.19. The age structure was 76.3% adult, 14.7% subadult, 5.2% juvenile and 3.8% foal. There was a rapid increase in their population during 1970-1985 and then a decline over the period 1991-1995. An integrated action involving implementation of effective awareness programme among the local people and improving the socio-economic standards of the communities in the Nechisar plains is essential for the management of the plains zebra in Nechisar National Park.

Resumen: El estatus poblacional, la estructura, la abundancia y las tendencias de la cebra de las planicies (*Equus quagga*) fueron estudiados en las planicies de Nechisar, Parque Nacional de Nechisar, sur de Etiopía, usando transectos y métodos de detección silenciosa. Se estimó que el tamaño poblacional de la cebra de las planicies en el área es de 4500, con una densidad poblacional de 16.6/km². Los tamaños promedio de las manadas del harem de un macho y de la de un potro soltero fueron 10.8 y 6.4, respectivamente. Los machos adultos constituyeron 34.8%, las hembras adultas 41.5% y los animales jóvenes no sexados 23.7%. La proporción macho:hembra fue 1.00:1.19. La estructura de edades fue 76.3% adultos, 14.7% subadultos, 5.2% juveniles y 3.8% potros. Hubo un incremento rápido en la población entre 1970 y 1985 y después una reducción durante el periodo 1991-1995. Es imperativo que se lleve a cabo una acción integrada que contemple la puesta en práctica de un programa efectivo de concientización entre la población local y que mejore los estándares socioeconómicos de las comunidades en las planicies de Nechisar, con el fin de lograr el manejo adecuado de la cebra de las planicies en el Parque Nacional de Nechisar.

Resumo: O status da população, estrutura, abundância e tendências da zebra das planícies (*Equus quagga*) foram estudadas nas planícies de Nechisar, Parque Nacional de Nechisar, sul da Etiópia, usando transeptos e métodos de detecção silenciosos. A população da zebra das planícies na área foi estimada em 4500, com uma densidade de população de 16,6/km². A dimensão média das manadas de um macho por harém e manadas de garanhões solteiros foram de 10,8 e 6,4, respectivamente. Os machos adultos totalizavam 34,8%, as fêmeas adultas 41,5% e os juvenis sem sexo definido 23,7%. O ratio macho: fêmea era de 1,00:1,19. A estrutura de idades era de 76,3% de adultos, 14,7% de sub-adultos, 5,2% juvenis e 3,8% de potros. Durante 1970-1985 verificou-se um rápido aumento da sua população e depois um declínio durante o período 1991-1995. Uma ação integrada, envolvendo a implementação de um programa efectivo de sensibilização entre a população local e melhorando os standards

* Corresponding Author; e-mail: balak212@yahoo.com

socio-económicos das comunidades das planícies de Nechisar, é essencial para a gestão das zebras das planícies no Parque Nacional de Nechisar.

Key words: Age structure, Nechisar National Park, plains zebra, population density, sex ratio.

Introduction

The genus *Equus* comprises six species and 22 subspecies. Three of these species (*Equus burchelli burchelli*, *Equus burchelli hunippus* and *Equus przewalskii*) are extinct (IUCN 1990). The three surviving species of zebras are the Mountain zebra (*Equus zebra*), Grevy's zebra (*Equus grevyi*) and plains zebra (*Equus quagga*) (Duncan 1992; Estes 1997; Kingdon 1979). The plains zebra or the common zebra, once ranged throughout eastern and southern Africa, except in areas of former forest belts in the western and central Uganda (Duncan 1992; Estes 1997; Stuart & Stuart 1997). At present, their distribution range is across the Somali-Masai arid zone through the southern savannah and marginally in the southwest arid zone, from southeastern Sudan to South Africa and Angola (Duncan 1992; Estes 1997).

In Ethiopia, major populations of plains zebra occur in Omo, Mago and Nechisar National Parks, and in Yabelo Wildlife Sanctuary (Bolton 1973; EWCO 1995; Kirubel 1985). Total population size of this species in the four protected areas was estimated to be around 2000 individuals (Duncan 1992). Since 1975, there was no effective protection in these parks, leading to heavy poaching (Graham *et al.* 1996; Schloeder 1996). At present, Nechisar National Park (Nechisar NP) holds the largest populations of plains zebra (EWCO 1995; Kirubel 1985), where their distribution is limited mainly in the Nechisar plains.

The plains zebra utilizes a broad range of savanna habitats from treeless short grassland to tall grassland and open woodland (Estes 1997; Stuart & Stuart 1997). This species is equipped to deal with both early flush and long tough stems. It is often the pioneer that leads the way into taller, more wooded or wetter pastures and prepares it for the wildebeests, gazelle and other

associated antelopes. Like other ungulates, it also frequents water bodies (Duncan 1992; Estes 1997).

Non-migratory African herbivores satisfy their nutritional requirements in a limited home range by seasonally shifting between habitats within their ranges (Delany & Happold 1979; Kingdon 1979). However, due to the ever-increasing human and livestock population pressure, habitat fragmentation and related factors, such seasonal movements of larger herbivores between their respective habitats have become infrequent. As a result, long-term survival of many of the protected areas and the populations of many of the larger herbivore species is not safe (IUCN 2000). The present investigation is aimed at studying the population ecology and trend of plains zebra in the Nechisar plains to gather data for their effective management and conservation in natural habitats.

Materials and methods

The present investigation was carried out in Nechisar plains, Nechisar NP, Ethiopia. The study area is located between 5°51' – 6°10'N latitudes and 37°32' – 37°48'E longitudes, 540 km south of Addis Ababa (Fig. 1). The area covers 270 km² of the plains zebra range. The area encompasses an altitude ranging between 1250 m and 1360 m. The annual pattern of rainfall in the region is bimodal, with a long rainy season during March - May, and a short rainy season during September - November. The mean annual rainfall is 895 mm. The mean annual maximum and minimum temperatures are 32.2°C and 17.4°C, respectively.

Many parts of the Nechisar plains are drainage basins. These shallow fresh-water lakes are major sources of water for zebras, which restrict their distribution and seasonal mobility towards these basins. The river Sermale that runs along the eastern most corner of the range is one of the permanent sources of water in the area. The two main vegetation types of the study area are

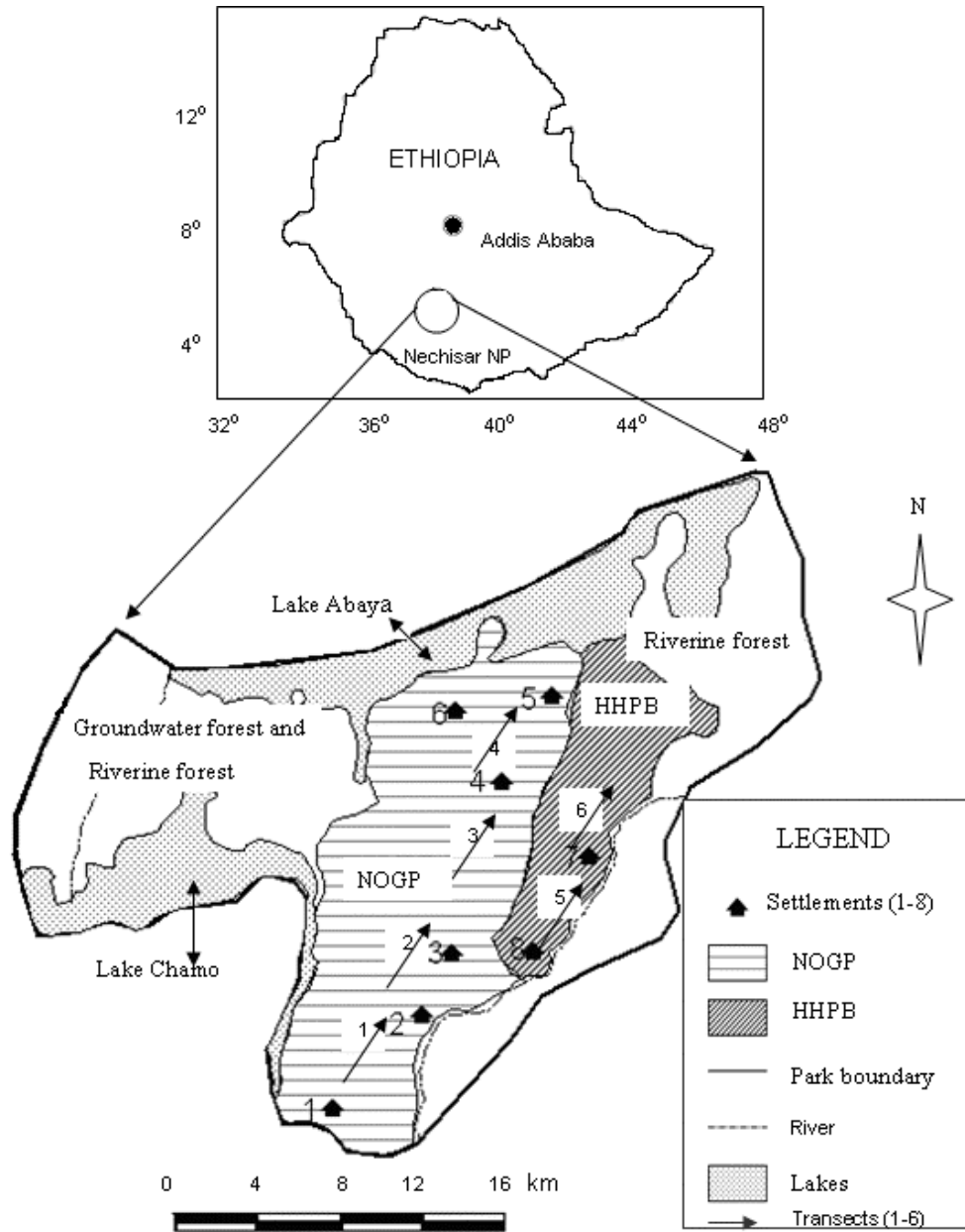


Fig. 1. Location map of the study area with the map of Ethiopia in box. NNP=Nechisar National Park, NOGP=Nechisar open grassy plains, HHPB=Hare hill plateau bushland, Settlements: 1=Gandullo, 2=Awarche, 3=Gode, 4=Watchole, 5=Mado, 6=Datche, 7=Hare, 8=Kordae.

Acacia-Commiphora deciduous woodland and savanna grassland.

In addition to plains zebra, the most frequent diurnal larger wild herbivores in the study area are the endangered Swayne's hartebeest (*Alcelaphus buselaphus swaynei*), Grant's gazelle

(*Gazella granti*) and Greater kudu (*Tragelaphus strepsiceros*) (Duckworth *et al.* 1992; Kirubel 1985). The major carnivores reported in the area are black backed jackal (*Canis mesomelas*), side striped jackal (*C. adustus*), hunting dog (*Lycan pictus*), cheetah (*Acinonyx jubatus*), leopard

(*Panthera pardus*), lion (*P. leo*), serval cat (*Felis serval*), caracal (*F. caracal*) and spotted hyaena (*Crocuta crocuta*).

An extensive survey was conducted in and around Nechisar NP prior to the intensive field work. Nechisar plains was identified to be the main study site because it harbours the highest concentration of plains zebra in Ethiopia. The area was spatially stratified into two main habitat types: the Nechisar plains (200 km²) of open grasslands and the bordering Hare hill plateau bushland (70 km²).

Transects were originated from a random point on the map of the study area. Initial points were then located using Global Positioning System (GPS). Six transects, each of 4 km long were sampled. Among these, four were in the Nechisar open grassy plains and two were on the Hare hill plateau bushland.

The available literature on the population status of the plains zebra was used to reveal their population trend during the period from 1970 to 2002 in the study area (Bolton 1973; EWCO 1995; Kirubel 1985).

A network of 177 km of main and subsidiary tracks in the Park formed the observation area for reconnaissance survey using a vehicle. Each of the monthly field observations consisted of a reconnaissance survey to determine the local distribution of plains zebra in the area, followed by intensive ground survey. Intensive ground survey was carried out along the six transects. This was done in the morning (06:00-11:30 h) and in the afternoon (15:30-18:00 h), twice a week for three months, both during the wet season (November 2001 & March to April 2002) and the dry season (December 2001 & January to February 2002). Each transect was traversed on foot at the speed of 4 km h⁻¹. Whenever plains zebras were observed, the distance and sighting angle from transects, observable activities, the presence of other large mammal species in the vicinity and the habitat types were recorded. Silent detection method was practiced to minimize disturbances (Wilson *et al.* 1996). Repeated counting of the same herd or cluster was avoided using recognizable features such as cluster size, harem composition and distinct individuals with body deformities such as cut tail and ear (Wilson *et al.* 1996). Thus, all herds were individually recognized.

Observations on feeding habits were made during their active feeding periods using binoculars (8x30 Field 7.5°) (Wilson *et al.* 1996). Troop size was recorded for all observations. Sex composition of adults and approximate age of all individuals observed at close ranges were recorded. Physical appearances such as the relative body size, external genitalia and furry-hair were used for sex and age class determination (Klingel & Klingel 1966). As it was difficult to confirm the sex of sub-adults, data on them were pooled together.

Data were analyzed to estimate the population density of the plains zebra using "DISTANCE" software programme (Buckland *et al.* 1993). Variances were large and consequently the lower limit of the 95% confidence interval (DS_{min}) was used as a conservative estimate of population size. For a better density estimate using DISTANCE analysis, the number of sighting should be > 60 (Buckland *et al.* 1993). However, the frequency of sighting plains zebra in Hare hill bushland was very low and hence the data for bushland were not considered to estimate population density of the zebra in the area. Population size was estimated by multiplying the population density with total area of the Nechisar plains (Wilson *et al.* 1996). Mann-Whitney U test was used to analyze the data on differences between mean sizes of the family harem and of bachelor stallion herds. Data on population structure, feeding and interspecific interactions were analyzed and compared by Chi-square test using computer programme SPSS 10.0 for Windows 1999.

Results

Data on observations of plains zebra during the transect count are given in Table 1. Data of wet season count (586) was more than of dry season count (477). Mean herd size ranged from 7.4 during the dry season to 9.7 during the wet season. The population density of plains zebra in Nechisar NP was estimated to be 16.6±1.5 (SE)/km² during the study period. The total population size estimate was 4482 individuals with 95% confidence interval (4077–4887). This population estimate was rounded to 4500. Data on population trend of plains zebra in Nechisar NP are given in Table 2. The population estimates of plains zebra in Nechisar NP during 1970-2002

Table 1. Number of herds, herd size and individual plains zebra counted on each transect during wet and dry seasons.

Transects	Season						Average		
	Wet			Dry			n _i	s _i	x _i
	n _i	s _i	x _i	n _i	s _i	x _i			
T ₁	15	9.2	138	14	8.1	113	14.5	8.6	125
T ₂	13	9.3	121	13	7.6	99	13.0	8.5	110
T ₃	15	9.1	136	12	8.2	98	13.5	8.7	117
T ₄	16	9.1	145	15	7.6	114	15.5	8.4	130
T ₅	3	9.7	29	5	7.4	37	4.0	8.3	33
T ₆	2	8.5	17	2	8.0	16	2.0	8.5	17
Total	64		586	61		477	63		532

n_i: mean number of herds (zebra clusters observed) per transect, s_i: herd size (mean number of individuals per cluster) per transect and x_i: sum of individuals counted per transect.

Table 2. Population estimates and trend of the plains zebra in the Nechisar plains.

Year	Population size	Trend	Methods & Source
1970	400	Increasing	Road count (Bolton 1973)
1985	6500	Increasing	Road count (Kirubel 1985)
1995	3000	Decreasing	Road count (EWCO 1995)
2001-2002	4500	Increasing	Distance Sampling Method (present study)

Table 3. Population structure of the plains zebra in the Nechisar plains.

Month & Year	n _i	x _i	Sex and age categories					Sex ratio AM:AF	Age ratio Ad:Yg
			AM	AF	SA	Juv	Fo		
Nov 2001	65	540	190	220	78	28	24	1:1.16	1:0.32
Dec 2001	62	529	183	218	80	30	18	1:1.19	1:0.32
Jan 2002	61	461	158	190	77	23	13	1:1.20	1:0.33
Feb 2002	60	441	153	184	75	20	9	1:1.20	1:0.31
Mar 2002	64	582	209	252	71	30	20	1:1.21	1:0.26
Apr 2002	66	637	220	264	85	35	33	1:1.20	1:0.32
Total	378	3190	1113	1328	466	166	117	-	-
Average	63	532	185	221	78	28	20	1:1.19	1:0.31

n_i = herds observed, x_i=number of individuals, AM=adult male, AF=adult female, SA=sub-adult, Juv=juvenile, Fo=foal, Ad=adult (AM+AF), Yg=young (SA+Ju+Fo).

indicated an increase during 1970-1985, a decline during 1991-1995 and again increase since 1996.

Data gathered on the population structure of plains zebra are given in Table 3. Adult male:female ratio was 1.00:1.19 and adult:young ratio was 1.00:0.31. They live in social groups of one-adult male harem or in bachelor stallion herd. The composition and structure of family harem and of the bachelor stallion herd are given in Table 4. There were more family herds than stallion

herds. The family harem consisted of 3 to 28 individuals, whereas the bachelor herd size ranged from 2 to 17 individuals. The group composition was fairly stable throughout the study period. The mean size of family harem was greater than that of the bachelor stallion herds ($Z=8.5$, $P<0.05$).

Plains zebra showed preference to certain species of grasses over other species ($P<0.05$). The foraging frequency was 33.8% on *Themeda triandra*, 23.0% on *Lintonia nutans*, 13.5% on

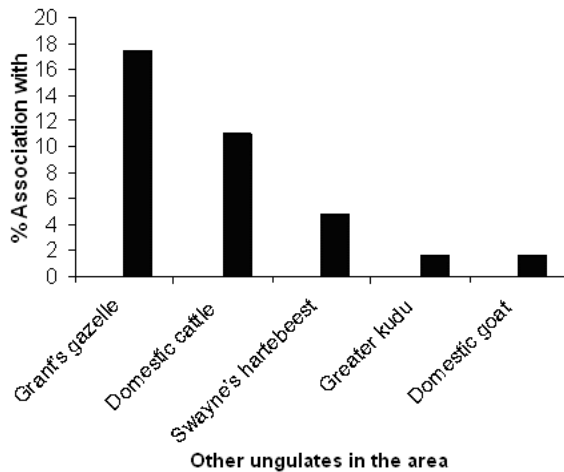


Fig. 2. Percentage frequency of association of plains zebra with other ungulates in the area.

Setaria sphacelata, 12.8% on *Ischaemum afrum*, 8.8% on *Chrysopogon aucheri* and 8.1% on *Cenchrus ciliaris*. *T. triandra* and *L. nutans* were the most preferred grasses accounting for 56.8% of the total sighting frequency of grass intake, whereas, *C. aucheri* and *C. ciliaris* were the least preferred species, which accounted only for 16.9% of the total intake frequency.

Plains zebra showed a tendency to associate with Grant's gazelle, Swayne's hartbeest, greater kudu, cattle and goats that ranged in their habitats. The percentage frequency of such association was more with Grant's gazelle than the other species (Fig. 2).

Discussion

The local people were forcefully evicted from

Nechisar NP by the previous military government of Ethiopia. As a result, the population of plains zebra showed an increase from 400 (Bolton 1973) to 6500 (Kirubel 1985) during 1970-1985. Kirubel (1985) reported the counts of the plains zebra following road count method of fixed sighting distance during the wet season and variable sighting distance during the dry season. His population density estimates were 13.4 km⁻² and 34.9 km⁻² for wet and dry seasons, respectively. However, during the 1991 political change in the country, the local people returned and occupied the Park. This resulted in a widespread destruction of natural habitats and depletion of plains zebra population during 1991-1995 (EWCO 1995). The current trend shows that the plains zebra population is recovering due to the implementation of strict wildlife management regulations including regular patrolling of Nechisar NP scouts. The use of different methods during different counts might have been a source of variation in the population density of plains zebra, which was used for extrapolation of population in the study area.

The current female biased sex ratio and the fairly high proportion of young in the population indicate a healthy and increasing population status of plains zebra in Nechisar NP. Out of the total 340 observations, 64.9% were of family herds and only 35.1% were of stallion herds. Adult male: adult female ratio of the family herd was 1.3:6.0 (Table 4). The sub-adult males are kept away from the family herd and hence form bachelor herd. They may also interact with various family herds from time to time to ensure better viable breeding populations.

Habitat requirements of plains zebra were closely associated with the availability of water and edible grasses. Lamprey (1963) estimated that

Table 4. Group composition and structure of the plains zebra in the Nechisar plains.

Month & Year	<u>No. of herds</u>		<u>Herd size, mean</u>		<u>Sex & age category of family herd</u>				
	Stallion	Family	Stallion	Family	AM	AF	SA	Juv	Fo
Nov 01	22	37	6.0	10.4	1.4	5.7	2.0	0.7	0.6
Dec 01	21	35	6.7	10.8	1.1	6.1	2.1	0.8	0.5
Jan 02	20	30	6.0	11.0	1.1	6.2	2.5	0.7	0.4
Feb 02	21	28	5.8	11.0	1.0	6.4	2.6	0.7	0.3
Mar 02	20	42	6.5	10.6	1.8	6.0	1.6	0.7	0.5
Apr 02	16	48	7.5	10.8	1.9	5.5	2.0	0.7	0.7
Total	120	220	38.5	64.6	8.3	36	13	4.0	3.0
Average	20	37	6.4	10.8	1.3	6.0	2.1	0.7	0.5

AM=adult male, AF=adult female, SA=sub-adult, Juv=juvenile, Fo=foal

92.5% of the food of zebra was grass, 5.4% was herb and 2% was shrub. In contrast, the present data show that grass comprises all the diet during both the wet and dry seasons in Nechisar NP. They were never observed browsing herbs and shrubs. Vesey-Fitzgerold (1965) noted that *Sporobolus* sp. and *Vossia* sp. are preferred grasses of Burchell's zebra (now renamed as plains zebra) in the Rungwa Valley, Tanzania. Even though plains zebra is known to feed on all grasses in the area, evidence from the stomach contents shows that the major food item comprises the dominant fire grass, *T. triandra* (Casebeer & Koss 1970). During the present investigation, the zebras fed mostly on the common grasses *T. triandra* and *L. nutans*.

Data of the present study showed that plains zebra live in areas where few other plain ungulates and livestock also depend upon. Plains zebra associate with Grant's gazelle more frequently than with other wild herbivores and livestock (Duncan 1992; Kirubel 1985). Such interactions would probably explain that the two species are not ecological competitors as revealed from different feeding strategies. Zebras feed on taller grasses but Grant's gazelle feed on shorter grasses (5-10 cm) and dicotyledonous herbs, which are not consumed by plains zebra (Delany & Happold 1979). The other plain ungulate that aggregates with plains zebra is Swayne's hartebeest. Both these species are grassland grazers. The Swayne's hartebeest feed on short grasses of 10-15 cm high with a large proportion of leaf and small proportion of stem but the plains zebra feed on tall grasses, mainly stem and leaf, all over the Nechisar plains (Vesey-Fitzgerold 1965). The Swayne's hartebeests may gain dilution effect of predation when associated with large herds of plains zebra. Bolton (1973) and Kirubel (1985) have pointed out that overgrazing severely deteriorated the Nechisar open grassy plain area and enhanced invasion of ticks during the dry season. During the present study, it was revealed that livestock was a major ecological competitor in the plains zebra range. A total of 7587 heads of cattle and goats was recorded from the households in the nearby villages (Yisehak *et al.* 2006). Yisehak (2003) has reported that there were competition by both the cattle and plains zebra for the major grass species in the area, *viz.*

T. triandra, *L. nutans*, *S. sphacelata*, *I. afrun*, *C. aucheri* and *C. ciliaris*.

Integrated actions involving effective awareness programme among the local people and improving the socio-economic standards of the communities in the Nechisar NP would help in better management and conservation of wildlife in the area as envisaged elsewhere in the African continent (Balakrishnan & Ndhlovu 1992). Livestock population should be controlled in Nechisar NP for conservation of the population of plains zebra in the Nechisar plains in view of the probability of disease transmission and competition for food, space and cover. Intensive grazing by domestic animals along with the wildlife populations might favour bush encroachment, which in turn would reduce the effective grazing area for zebra. To this effect, attempt is already being made to minimize the pressure on wildlife by translocating the inhabitants with their cattle to a different area. Even though, forced de-stocking is known to have cultural implications, this move is supported because every effort is being made to help these people to be economically self-sufficient on a sustainable basis. Effective buffer zone all around Nechisar NP is to be established, where local people can depend upon for essential requirements, including herding. Further, the Park can be expanded to the south to include potential ranges of plains zebra population. Involvement of diverse stakeholders through community based conservation activities is expected in Nechisar NP for the plains zebra populations to survive through generations.

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