

PART 1

Species Status and Conservation Action Plans: Africa

Status and Action Plan for the African Wild Ass (*Equus africanus*)

Patricia D. Moehlman

1.1 Nomenclature and conservation status

Scientific name:

Equus africanus Heuglin and Fitzinger 1866
Equus africanus africanus Heuglin and Fitzinger 1866
Equus africanus somaliensis Noack 1884

Important synonyms: *Equus asinus*

Common names:

African wild ass, Somali wild ass, Abyssinian wild ass, Nubian wild ass

Indigenous names:

Dabokali (Afar), Adghi Bareka (Tigrinia), Eritrea
Gumburiga (Issa), Dibakoli (Afar), Ethiopia, Gumburiga, Gumburi, Somalia

IUCN Red List Category (version 2.3):

Equus africanus **CR A1b** Critically Endangered
E. a. africanus **CR A1b** Critically Endangered
E. a. somaliensis **CR A1b** Critically Endangered

CITES Listing:

Equus africanus Appendix I
E. a. africanus
E. a. somaliensis

1.2 Biological data

1.2.1 Distribution

During the Pleistocene, the African wild ass may have existed in Israel and Syria. Historically, there were three recognised subspecies. The Atlas wild ass, *Equus africanus atlanticus*, was found in the Atlas region of north-western Algeria, and adjacent parts of Morocco and Tunisia. It survived in this area until about 300 AD (Antonius 1938). In recent times, there have been reports of wild asses in northern Chad and the Hoggar Massif of the central Sahara, but it is in doubt as to whether these are true wild asses.

The Nubian wild ass, *Equus africanus africanus*, lived in the Nubian desert of north-eastern Sudan, from east of the Nile River to the shores of the Red Sea, and south to



The African wild ass (*Equus africanus*).

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the Atbara River and into northern Eritrea. During aerial flights in the 1970s, wild asses were seen in the Barka Valley of Eritrea and in the border area between Eritrea and the Sudan (Watson 1982).

The Somali wild ass, *Equus africanus somaliensis*, was found in the Denkelia region of Eritrea, the Danakil Desert and the Awash River Valley in the Afar region of north-eastern Ethiopia, western Djibouti, and into the Ogaden of eastern Ethiopia. In Somalia, they ranged from Meit and Erigavo in the north to the Nugaal Valley, and as far south as the Shebele River (Ansell 1971; Klingel 1980; Moehlman 1989). The most comprehensive review of the historical literature concerning African wild ass distribution is in Yalden *et al.*'s *Catalogue of the Mammals of Ethiopia* (1986). There is disagreement in the scientific literature as to whether the African wild ass is one continuously distributed species or if there are valid subspecies (Ansell 1971; Groves and Willoughby 1981; Ziccardi 1970; Yalden *et al.* 1986). According to Watson (1982), there is a semi-continuous population extending from northern Somalia into Ethiopia and, possibly, through Eritrea and into the Sudan. A matter of perhaps greater concern is the genetic integrity of the wild stock, e.g. determining if wild populations are interbreeding with domestic donkeys (*Equus africanus familiaris*, Gentry *et al.* 1996).

1.2.2 Population estimates and trends

Somalia

Between 1978 and 1980, Watson (1982) conducted aerial surveys in northern Somalia and estimated a population of 4,000–6,000 wild asses in the area from the Nugaal Valley to the Djibouti border. Given the area covered by the survey, this would indicate approximately six wild asses per 100km². Between 1979 and 1982, Simonetta and Simonetta (1983) estimated about 250 wild asses in the north-western Nugaal Valley and about 50 wild asses near Meit, with scattered groups occurring along the coast in the Erigavo region. In 1989, a ground survey with limited aerial reconnaissance in the Nugaal Valley yielded population estimates of roughly 135 to 205 wild asses or approximately 2.7 to 4.1 asses per 100km² (Moehlman 1998). This indicates, perhaps, a 50% reduction in the wild ass population during the decade between those surveys. In 1997, Moehlman returned to the Nugaal Valley, but was not able to survey the entire area. Local pastoralists, however, said that there were less than ten African wild asses left in the Nugaal Valley.

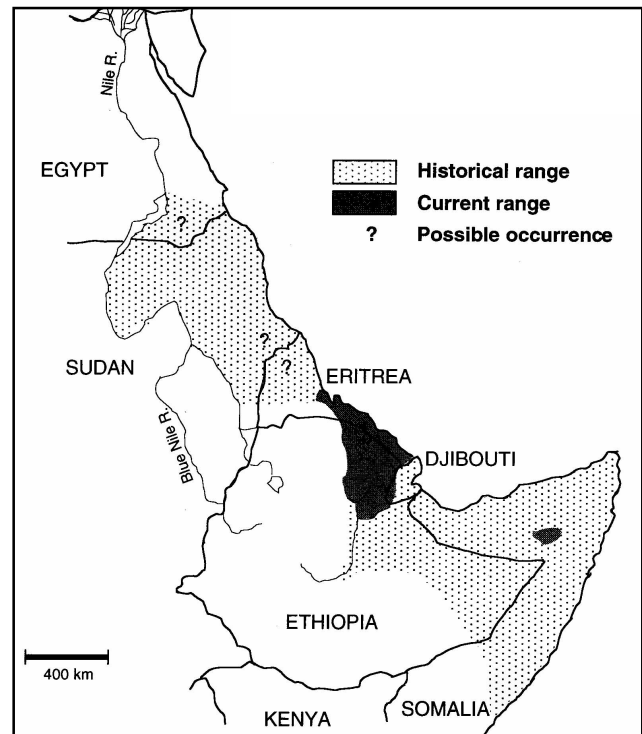
Ethiopia

During 1970 and 1971, Klingel and Watson conducted an aerial survey of the Teo area (5,280km²), the Tendaho-Serdo area (4,270km²), and the Lake Abbe area (6,550km²). Klingel (1972) estimated a total of 3,000 wild asses or 18.6

per 100km². The Teo area, which is now part of the Yangudi-Rassa National Park, had the highest density with 30 wild asses per 100km². In May/June 1972, the Catskill Game Farm captured 12 wild asses in the valleys to the north-west of Serdo. During the eight-day period, a total of four more wild asses were captured and released, and an additional 37 wild asses were observed. This is within an area of approximately 350km². Thus, there were approximately 15 African wild asses per 100km². In 1976, Stephenson (1976) carried out an aerial survey in an area similar to Klingel's Teo area and in an area of 3,990km² had an estimated wild ass density of 21.0 per 100km². In July/August 1995, Thouless (1995) conducted aerial surveys of the Yagudi-Rassa National Park (Teo area) and the adjoining wildlife reserves, and observed no African wild asses.

Starting in January 1994, Moehlman and Kebede conducted surveys of the Yangudi-Rassa National Park and the Mille-Serdo Wild Ass Reserve (Moehlman 1994a, 1994b; Kebede 1994, 1995; Kebede and Ayele 1994). Issa nomads were utilising the Yangudi-Rassa National Park and, in some areas, their herds of sheep and goats were in excess of 50 per km² (Thouless 1995). No wild asses were seen and oral reports from local inhabitants indicated that wild asses were rare and probably existed at a density of well below one per 100km². Thus, in an area where Klingel and Stephenson had observed approximately 20–30 wild asses per km² in the 1970s, 20 years later the population exists at a critically low level.

Figure 1.1. Historic and current distribution of the African wild ass (*Equus africanus*).



In the Mille-Serdo area, Moehlman and Kebede surveyed the area to the north-west and to the south of Serdo (2,000km²). In areas where Klingel and the Catskill Game Farm personnel had observed 15 to 18.6 wild asses per 100km², and Klingel (1977) had observed temporary groups of 43 and 49 individuals, Moehlman and Kebede (1994–1996) could find a total of only ten wild asses. The largest group observed between 1994 and 1996 had six individuals.

Similar to previous observations (Klingel 1977), a solitary male occupied a consistent territory. Small, temporary groups were composed of females and their offspring, and occasionally an adult male. At present, observations indicate that mother and offspring comprise the only stable groups. This is the only area in Ethiopia where it has been possible to consistently see African wild asses, but they are very low in density, and it requires days of walking the volcanic mountains to see these very wild and shy animals. Even if as many as one African wild ass per 100km² exists throughout the species' former range (16,000km²), the population in Ethiopia probably numbers less than 160 individuals. Since most local pastoralists carry automatic rifles, wildlife continues to be at risk of (over) exploitation (Moehlman *et al.* 1998).

Eritrea

Due to Eritrea's 30-year war for independence, there are no long-term data on African wild ass populations. However, recent surveys indicate that viable populations exist in the area between the Buri Peninsula and the Denkelia Depression (Moehlman *et al.* 1998). In 1998, the team of Moehlman, Yohannes, Hagos, Woldu, and local Afar pastoralist, Saleh Mohamed Abdullah, went by foot

and camel to the Messir Plateau. In an area of approximately 50km², they were able to identify individuals and determine a population density of roughly 47 African wild asses per 100km². This is the highest population density found anywhere in the present range of the species and is similar to population densities recorded in Ethiopia in the early 1970s. Currently, the African wild ass density in other locales is less than one individual per 100km². The Messir Plateau is part of the Asaila Mountains, a range that covers approximately 800km². A potentially viable population of approximately 400 African wild asses may extend through the Danakil Depression to Ethiopia. Given the absence of guns among rural people and the conservation ethic among local Afar pastoralists, the African wild ass has good potential for recovery in Eritrea.

1.3 Behavioural ecology

The African wild ass in the deserts of Eritrea and Ethiopia live in temporary groups that are small and typically composed of fewer than five individuals. The only stable groups are composed of a female and her offspring. In temporary groups, the sex and age-group structure varies from single-sex adult groups to mixed groups of males and females of all ages. Adult males are frequently solitary, but also associate with other males. Adult females usually associate with their foal and/or yearling. Some adult males are territorial and only territorial males have been observed copulating with estrous females. Thus, the African wild ass exhibits the social organisation typical of equids that live in arid habitats (Klingel 1977; Moehlman 1998).

Table 1.1. <i>Equus africanus somaliensis</i> population estimates.					
Location	Year	Year	Year	Comments	Trend
Somalia					
Nugaal Valley	1982 : 250 Simonetta and Simonetta (1983)	1989 : 100 Moehlman (1989)	1997 : 10 Moehlman (1998)	1982: Ground survey 1989: Ground and aerial 1997: Ground survey and interview	Decreasing
Ethiopia					
Yangudi Rasa	1971 : 1,584 5,280km ² Klingel (1972)	1976 : 838 3,990km ² Stephenson (1976) 21/100km ²	1995 : 0 2,800km ² Thouless (1995)	1971: Aerial survey 1976: Aerial survey 1995: Aerial survey	Decreasing
density =	30/100km ²		0/100km ²		
Mille Serdo	1971 : 794 4,270km ² Klingel (1972)	1972 : 53 350km ² Moehlman <i>et al.</i> (1998)	1994–98 : < 20 2,000km ² Moehlman <i>et al.</i> (1998)	1971: Ground survey 1972: Ground survey 1998: Ground survey	Decreasing
density =	18.6/100km ²	15/100km ²	<1/100km ²		
Eritrea					
density =			1997–2000 Moehlman and Yohannes ~40/100km ²	1997–2000 Ground survey 50km ²	Stable

In feral asses, the age of first estrus is about 12 months. With a 330 to 365-day gestation period, a female could potentially have her first foal at two to two and a half years of age (Kenneth 1953). However, in the south-western United States, feral asses typically have their first foal at three and a half to four years of age (Moehlman 1974). Estrous cycles have been described for *Equus ferus* (horse) as being 20 to 21 days, with estrus lasting five and a half days and ovulation occurring 24 to 28 hours before the end of estrus (Hughes *et al.* 1972). Postpartum estrus could occur from seven to nine days after the birth of a foal. Age of first estrus has not been documented in free-living African wild asses, but age of puberty may be similar to that of their domestic descendants. In Eritrea, African wild ass females are polyestrous and natality occurs from October to February.

In Eritrea and Ethiopia, limited observations indicate that African wild asses are primarily grazers (Moehlman *et al.* 1998; Kebede 1999). The only stable groups are composed of a female and her offspring. Females do associate with other females or with males, but even temporary groups are small. Low density and low sociability may be due to low forage quality and availability (Jarman 1974). Ginsberg (1988) found that Grévy's zebra group size correlated with food density and, at biomass levels below 40g/m², there was only food sufficient for a female and her foal. He also documented that during a drought period when the mean biomass levels were just above 40g/m², the normally stable plains zebra harem and bachelor groups became unstable. Such data strongly suggest that the stability and size of groups reflect the distribution and availability of food.

Research on feral asses has documented that they are physiologically well adapted to life in arid habitats. They can sustain a water loss of up to 30% of their body weight and can drink enough water in two to five minutes to restore fluid loss (Maloiy 1970; Maloiy and Boarer 1971). Tomkiewicz (1979), using temperature sensitive implants, determined that feral asses varied their body temperature from 35.0 to 41.5°C, depending on air temperature. In hot summer months, males had lower mean body temperatures (36.5°C) than females (38.2°C). Females maintained higher body temperatures and presumably lost less water due to sweating. A two degree increase in body temperature could provide a two percent daily water savings in a hydrated 150kg feral ass. Tomkiewicz also found that the biological half-life of water for females was one day longer than for males, indicating that their water use was more efficient. Such information indicates that the ancestral species, the African wild ass, is physiologically very well adapted to life in the deserts of Eritrea, Ethiopia, and Somalia. However, the African wild ass still needs access to surface water and the movements of lactating females are constrained by water availability. During aerial surveys in the Danakil Desert of Ethiopia (12,000km, Stephenson

1976), most African wild asses were observed within 30km of known water sources.

Individuals will form groups when benefits exceed costs in terms of feeding, predation, disease, and reproduction (Alexander 1974). The density, continuity of distribution, and biomass of forage are key factors in the stability of association and the spacing of equids (Duncan 1983; Rubenstein 1986, 1994; Ginsberg 1988). However, review of the literature indicates that water distribution and predation pressure are also important factors. When forage and water availability allow females to be gregarious and form stable groups, then a male can attempt to control access to these females. Amongst equids, these female groups form strong bonds and, if a male is removed (Hartmann's mountain zebra: Joubert 1972; horses: Imanishi 1950, Tyler 1972) or displaced (plains zebra: Klingel 1967, 1972), the females often maintain a stable group. Age and fighting ability and the adult sex ratio can also affect a harem male's success in defending his female group against bachelor males. Among equid populations that have a harem mating system (female-defence polygyny), the following have been observed: 1) multi-male harem groups in which all males defend the females and the dominant male achieves the most copulations (feral horses: Keiper 1976, Green and Green 1977, Miller and Denniston 1979, Feist 1971, Nelson 1979; feral asses: Moehlman 1979, McCort 1980), 2) harem males that form alliances and cooperatively defend their harems (plains zebras: Rubenstein 1986), and 3) populations in which adult male sex ratio is significantly low and single-male harems encounter less intrusion/harassment from bachelor males (feral horses: Rubenstein 1986). Harassment involving chases and copulations can negatively affect a female's feeding rate and may even result in abortion (Berger 1986) or involve infanticide (Duncan 1982).

A prerequisite for the 'cost-effective' viability of 'female-defence' polygyny (stable family or harem groups) is a spatial and temporal patterning of resource availability such that it is possible for females to feed in close proximity (Emlen and Oring 1977). In more mesic habitats, forage for ungulates tends to be more abundant with a more continuous distribution. Jarman (1974) reviewed antelope feeding ecology and social organisation and found that group size correlated strongly with food availability and feeding strategy. Large stable groups were more likely to form when one individual's foraging did not adversely affect conspecifics' foraging. Consequently, closer spacing and larger aggregations were possible when food was abundant. Conversely, food shortages would tend to limit group size and stability.

Predation pressure on large mammals, like equids, should increase the tendency to form groups in order to improve detection of and/or defence against predators. The potential for polygyny among equids is further enhanced because 1) females are able to provide nutritional

care for their young, and 2) females do not come into estrus synchronously, which enables a male to mate with several females. Thus, in a mesic habitat, a male can control access to multiple females by virtue of their gregariousness and their non-synchronous estrus. From the female point of view, abundant food allows closer spacing with other females and gregariousness enhances predator detection. In addition, the presence of a dominant male precludes harassment by other males in the population.

By contrast, in more arid environments, limited food availability (both spatially and temporally) usually does not permit females to forage in close proximity and/or to be associated consistently. In dry habitats, equids exhibit the same nutritional and reproductive characteristics (e.g. females provide nutrition and females tend to come into estrus asynchronously), which allow males to attempt multiple matings, but 'indirectly' control access to the females. In most cases, they actually control access to a critical resource, i.e. water. In these territorial mating systems, the only stable social group is a female and her offspring (Klingel 1972, 1974, 1977; Moehlman 1974, 1979; Woodward 1979; Ginsberg 1988, 1989; Becker and Ginsberg 1990; Rowen 1992).

Male feral asses in Death Valley National Monument (Moehlman 1974, 1979) and Grévy's zebra (Ginsberg 1988, 1989) hold territories adjacent to localised water sources. Females must pass through these territories to drink. Furthermore, females with young foals (<1.5 months of age) are water stressed, drink three times as often as other adults in the population, and tend to stay within one kilometre of water (Moehlman 1974). Feral ass females will come into estrus seven to nine days after parturition. If they are not fertilised during their post-partum estrus, then they will come into estrus again in 28 to 30 days. Thus, females with newborn foals will spend the first one and a half months on a territory near water and potentially will come into estrus twice during this time period. On these territories, they will have improved access to water, reduced harassment from bachelor males and interference with feeding, and potentially better anti-predator protection. Territorial males gain access to multiple matings by controlling the resources that females require a 'resource-defence' strategy (Emlen and Oring 1977).

Information is needed on the reproductive biology and population dynamics of the extant populations of African wild ass in the Afar region of Ethiopia, the Denkalia Desert of Eritrea, and the Nugaal Valley of the Somali Democratic Republic. Data are limited, but indicate that female wild asses have their first foal at age three to four years and will typically have a surviving foal every other year. In terms of population dynamics, this means that African wild asses are particularly sensitive to predation. Computer simulations for equids indicate that if all females

four years and older regularly produced foals, the survival rate would have to be 70% for foals and 85% for adults to enable the population to increase at a rate of four percent per year. This would allow the population to double in 18 years (Wolfe 1980). If mortality is high, due either to hunting and/or drought, the population will decline and it may be difficult or impossible for it to recover.

1.4 Actual and potential threats

The major threats to the survival of the African wild ass are 1) hunting for food and medicinal purposes, 2) potential competition with livestock for vegetation and water, and 3) possible interbreeding with the domestic donkey.

Research by Kebede (1999) in Ethiopia revealed that 72% of 65 adult male Afar pastoralists had killed African wild asses for food and/or medicine because they could not afford to buy medicine or they were too far from medical facilities. In Somalia, local pastoralists kill African wild ass for food and/or medicine. In interviews, they said that body parts and soup made from bones were good for curing tuberculosis, constipation, rheumatism, backache, and boneache. They feed the soup to their livestock to alleviate mineral deficiencies. When guns and bullets were rare and expensive it was difficult to shoot the wild ass. Currently, Kalashnikov automatic rifles are easy to obtain and bullets are cheap. Several elders said that the killing of the wild ass was the work of a few people (Moehlman *et al.* 1998). In Eritrea, the Afar pastoralists do not shoot wildlife and guns are strictly controlled.

African wild asses live in arid habitats where grass occurs in widely dispersed patches of low biomass. Competition between females for forage may limit their ability to form long-term associations. The only stable unit is mother and offspring. Access to water is critical and lactating females need to drink every day. The African wild ass has a resource-defence polygyny mating system in which males defend mating territories that contain the resources that females require (Klingel 1972, 1977; Moehlman 1974, 1979, 1998). Typically, these critical resources are water and forage. During aerial surveys in Ethiopia in the 1970s, African wild asses were always observed within 20 to 30km of known water sources (Stephenson 1976). Data on movement patterns and feeding ecology would provide information on how the African wild ass are utilising resources in areas that are also needed by pastoralists and their herds of camel, sheep, and goats.

If African wild ass are protected (i.e. not killed for meat or medicine), then the major remaining threat is access to water and sufficient forage. Reproductive females and their less than three-month old foals are most at risk. Hence it is important to determine critical water supplies and basic forage requirements, thus allowing management

authorities to determine in consultation with local pastoralists how to conserve the African wild ass. In Eritrea, Ethiopia, and Somalia, all elders were concerned that the African wild ass be protected and conserved. Chapter 13 highlights the information needed for a complete and appropriate ecosystem analysis.

1.5 Current legal protection

Ethiopia: Wildlife laws (Negarit Gazeta No.7 1972) categorise the African wild ass under Schedule 6, Specially Protected Animals and Birds. This legal status means that the African wild ass cannot be hunted and/or killed, and there are no exceptions and/or special permits. The Yangudi-Rassa National Park (4,731km²) and the Mille-Serdo Wild Ass Reserve (8,766km²) were established in 1969 (Hillman 1993). However, the Yangudi-Rassa National Park has never been gazetted, and both areas are utilised by large numbers of pastoralists and their livestock. These areas are remote and extremely arid, and the Ethiopian Wildlife Conservation Organisation (EWCO) has not had sufficient funds or personnel for appropriate management (Kebede 1999). Ethiopia is a signatory to CITES.

Eritrea: Eritrea, as a new nation, is currently writing its environmental laws. The African wild ass has protected status and cannot be hunted and/or killed, but, to date, there is no formal legal protection. In 1995, during their first International Conference on the Environmental Management Plan for Eritrea (NEMP-E), the Government of Eritrea designated the African wild ass area between the Buri Peninsula and the Dalool Depression as a high-priority area for conservation protection as a nature reserve (Government of Eritrea 1995). Eritrea is a signatory to CITES.

Somalia: The African wild ass presently may occur in the Puntland, Somaliland, Sool, and Sanag regions. These areas are individually administered and the African wild ass has no legal protected status.

Sudan: The African wild ass was legally protected in 1963 (Schomber 1963), but its present status is unknown.

1.6 Captive populations

In 1999, the population of captive Somali wild ass (*Equus africanus somaliensis*) reported to the International Species Information System (ISIS) totalled 94 individuals, of which 46 were males and 48 were females (C. Pohle *pers. comm.*, 1999). These captive African wild asses are the descendants of five wild asses (three males and two females) captured in the Nugaal Valley of Somalia and sent to the Basel Zoo in Switzerland in July 1970, and 12 wild asses captured in the Serdo area of the Danakil Desert of

Ethiopia in September 1972 and sent to Hai-Bar in Israel.

Jenny Slunga and Simon Wakefield (*pers. comm.*, 1998) reviewed the status of the captive population as stated in the 1996 International Studbook of African Wild Asses. They used SPARKS 1.4 (Single Population Animal Record Keeping System 1996) to analyse the genetic status of the captive population. The record keeping at Hai Bar did not track parentage, hence, the analyses were restricted to the data in the studbook, which included asses imported from Hai-Bar. Some relationships were uncertain; their best case assumed ten founders and their worst case assumed six founders.

Slunga and Wakefield determined that theoretically, after 25 years in captivity, the 1996 captive population of Somali wild ass had retained 90.3% of their wild genetic variability in the best-case scenario and 85% in the worst-case scenario. Under the best case scenario, they predicted that a captive population of 440 asses would be needed to retain 85% of the wild genetic variation for a 100-year period and that a population of 130 asses would retain 80% of the wild genetic variation. Given the worst case scenario, 140 asses would retain only 74% of the wild genetic variation.

Slunga and Wakefield's analyses of inbreeding in the 1996 captive population indicated that there was no significant difference in survival to the age of three years between inbred and non-inbred asses. However, offspring of full sibling matings had a 17.5% higher risk of dying before the age of 180 days given the best case founder scenario. If the proportion of inbred mating increases in the captive population, then the risk of inbreeding depression will increase. Their analyses of mixed-origin mating (Ethiopia and Somalia) did not indicate any possible outbreeding depression.

At present, the true genetic relationships of the Somali wild ass are unknown. Such information is critical to the sound management of the captive population of Somali wild ass into the future.

1.7 Research activities

In Ethiopia, Kebede, Moehlman, and Tadesse are conducting research on present population size, reproductive biology, habitat requirements, and interactions with local pastoralists and their domestic livestock. Fecal samples are being collected to determine the current level of genetic variation in this population, and to investigate whether hybridisation has occurred between wild asses and domestic donkeys.

In Eritrea, Moehlman and Yohannes are collecting data on African wild ass reproductive biology, population dynamics, social organisation, and feeding ecology on the Messir Plateau. These data on movement patterns and

feeding ecology will provide information on how the African wild ass is utilising resources at its current density levels in areas also needed by pastoralists and their livestock. Data on known individuals will provide information on natality and survivorship and allow a limited projection of population growth and viability. Moehlman and Yohannes will also survey the Yob area of northern Eritrea, which is another potential African wild ass area. Primary research goals for the Messir Plateau and the Yob populations are 1) determine the present distribution and population numbers, and 2) examine the genetic variation in these two isolated populations and determine the validity of their subspecific designation. Genetic analyses would also answer the question of whether hybridisation has occurred with domestic donkeys. DNA would be extracted from dried fecal samples of African wild asses and compared with that of local domestic donkeys.

In Somalia, Moehlman and Hassan Abshir Farah will survey the present status of the African wild ass in the Nugaal Valley.

1.8 Gaps in knowledge

At present better information is needed on:

- national and local population status and trends;
- genetic definition of subspecies;
- genetic viability of isolated and reintroduced populations;
- behavioural ecology, resource requirements, disease epidemiology, and demography;
- risk assessment of geographically distinct populations; and
- socio-economics and viability of alternative conservation/utilisation strategies.

1.9 Recommended actions

Improve the protection and management of existing populations

The African wild ass in the Mille-Serdo Wild Ass Reserve in Ethiopia needs better protection. Given the present lack of resources for EWCO staff and logistics, a small conservation education programme with the local Afar pastoralists may be the most practical option in the near future. However, if this population is to survive into the next two decades, then a management programme that involves Afar regional administrative personnel needs to be developed and implemented. The current African wild ass population cannot sustain the present poaching for meat and medicine.

In Eritrea, the African wild ass population between the Buri Peninsula and the Dalool Depression is 'protected' due to the cultural traditions of the local Afar pastoralists.

In this area, wildlife is not hunted and/or utilised for meat or medicine. However, the Messir Plateau may be a critical breeding area and legally declaring it a wildlife reserve would provide further protection.

In Somalia, a viable population of African wild ass may no longer exist in the Nugaal Valley. A survey and a viability assessment of the remaining population are needed, recognising the political constraints.

New reserves should be established as multiple-use areas with special protection for wildlife and appropriate development and extension support for local nomads. Throughout their range, African wild ass occur in arid habitats where the local human populations are at risk. Conservation of wildlife will not be possible unless local nomadic pastoralists have an opportunity to participate in, and benefit from, the conservation management of their areas. This should involve discussions and education concerning the conservation of natural resources and rare species, the employment of local personnel as rangers, and the provision of medical and veterinary care. In all three countries, further training for wildlife scientists and managers is fundamental to optimising conservation management of natural resources and endangered species.

Clarify the genetic status of the two subspecies of African wild ass

It is important to determine if *Equus africanus somaliensis* and *Equus africanus africanus* are morphologically, genetically, and behaviourally distinct subspecies that require separate conservation management programs. Survey work throughout the species range should determine if any populations are reproductively isolated and thus vulnerable to the demographic and genetic problems characteristic of small populations. In addition, the extent of interbreeding with domestic donkeys needs to be assessed with respect to its potential impact on the genetic integrity of existing African wild ass populations.

Extend surveys and improve monitoring of known populations

Surveys need to be extended to northern Eritrea and into Sudan and Egypt. At the same time, known populations need to be monitored as to age and sex class, and, where possible, natality and survivorship. These data are needed to prioritise conservation action.

Conduct research on basic biology, seasonal movements, and interactions with livestock

Research is needed on the reproductive biology, habitat requirements, seasonal movements, and interactions with local pastoralists and their domestic livestock. It is critical to involve local pastoralists in the development and implementation of a long-term management plan for the conservation of African wild ass and the desert ecosystem it inhabits.

1.10 References

- Alexander, R.D. 1974. The evolution of social behavior. *Ann. Rev. Ecol. Syst.*, 5, 325–383.
- Ansell, W.F.H. 1971. Order Perissodactyla. Pp. 1–14 in: *The mammals of Africa* (eds. J. Meester and H.W. Setzer). Smithsonian Inst. Press. Washington D.C.
- Antonius, O. 1938. On the geographical distribution in former times and today of the recent Equidae. *Proc. Zool. Soc. Lond.*, 107(4), 557–564.
- Becker, C.D. and Ginsberg, J.R. 1990. Mother-infant behaviour of wild Grévy's zebra: adaptations for survival in semi-desert East Africa. *Anim. Behav.*, 40, 111–1118.
- Berger, J. 1986. Wild horses of the Great Basin. The University of Chicago Press, Chicago and London. 326pp.
- Duncan, P. 1982. Foal killing by stallions. *Appl. Anim. Ethol.*, 8, 567–570.
- Duncan, P. 1983. Determinants of the use of habitat by horses in a Mediterranean wetland. *J. Anim. Ecol.*, 52, 93–109.
- Emlen, S.T. and Oring, S.W. 1977. Ecology, sexual selection, and the evolution of mating systems. *Science*, 197(4300), 215–223.
- Feist, J.D. 1971. *Behavior of feral horses in the Pryor Mountain Wild Horse Range*. M.S. thesis. University of Michigan, Ann Arbor. 129pp.
- Gentry, A., Clutton-Brock, J., and Groves, C.P. 1996. Proposed conservation of usage of 15 mammal specific names based on wild species which are antedated by or contemporary with those based on domestic animals. *Bull. Zool. Nomen.*, 53(1), 28–37.
- Ginsberg, J.R. 1988. *Social organization and mating strategies of an arid adapted equid: The Grévy's zebra*. PhD thesis, Princeton University, Princeton, New Jersey. 268pp.
- Ginsberg, J.R. 1989. The ecology of female behavior and male mating success in the Grévy's zebra, *Equus grevyi*. *Symp. Zool. (Lond.) Soc.*, 61, 89–110.
- Government of Eritrea. 1995. *Environment Eritrea: The National Environmental Management Plan for Eritrea*. 138pp.
- Green, N.F. and Green, H.D. 1977. The wild horse population of Stone Cabin Valley, Nevada: A preliminary report. *Proc. Nat. Wild Horse Forum*, 1, 59–65.
- Groves, C. P. and Willoughby, D.P. 1981. Studies on the taxonomy and phylogeny of the genus *Equus* 1. Subgeneric classification of the recent species. *Mammalia*, 45(3), 321–354.
- Hillman, J.C. 1993. *Compendium of wildlife conservation information*. Information on Wildlife Conservation Areas. NYZS and EWCO, Addis Ababa, Ethiopia. 226pp.
- Hughes, J.P., Stabenfeldt, G.H., and Evans, J.W. 1972. Estrus cycle and ovulation in the mare. *J. of Amer. Veter. Med. Assoc.*, 161(11), 1367–1374.
- Imanishi, K. 1950. Social life of semi-wild horse in Toimisaki, III. Summary for three surveys undertaken in 1948–1949. *Physiol. and Ecol. (Japan)*, 4, 29–42.
- Jarman, P.J. 1974. The social organization of antelope in relation to their ecology. *Behaviour*, 48, 215–267.
- Joubert, E. 1972. The social organization and associated behavior in Hartmann zebra, *Equus zebra hartmannae*. *Madoqua*, 1(6), 17–56.
- Kebede, F. 1994. *A field report on the survey of African wild ass in the Mille-Serdo Wild Ass Reserve*. January 25–February 3, 1994. Report to EWCO, Addis Ababa, Ethiopia. 4pp.
- Kebede, F. 1995. *A field report on the survey of the African wild ass in Serdo area*. November 25–December 3, 1995. Report to EWCO, Addis Ababa, Ethiopia. 7pp.
- Kebede, F. 1999. *Ecology and conservation of the African wild ass (Equus africanus) in the Danakil, Ethiopia*. MSc thesis, University of Kent, England. 79pp.
- Kebede, F. and Ayele, S. 1994. *A field report on the survey of the African wild ass status in Mille-Serdo Wild Ass Reserve and the surrounding area*. May 12–26, 1994. Report to EWCO, Addis Ababa, Ethiopia. 26pp.
- Keiper, R.R. 1976. Social organization of feral ponies. *Proc. Pennsylv. Acad. Sci.*, 50, 69–70.
- Kenneth, J.H. 1953. *Gestation periods*. Commonwealth Agricultural Bureau, Farnham Royal, Slough, Bucks, England. 39pp.
- Klingel, H. 1967. Soziale organisation und verhalten freilebender Steppenzebras (*Equus quagga*). *Z. Tierpsychol.* 24, 580–624.
- Klingel, H. 1972. *Somali Wild Ass: Status survey in the Danakel region, Ethiopia*. WWF Project no. 496. Final Report to EWCO, Addis Ababa, Ethiopia. 12pp.
- Klingel, H. 1974. Social organization and behaviour of the Grévy's zebra. *Z. Tierpsych.*, 35, 37–70.
- Klingel, H. 1977. Observation on social organization and behaviour of African and Asiatic wild asses (*Equus africanus* and *E. hemionus*). *Z. Tierpsychol.*, 44, 323–331.
- Klingel, H. 1980. *Survey of African Equids*. IUCN Species Survival Commission Report. IUCN, Gland, Switzerland. 15pp.
- Maloiy, G.M.O. 1970. Water economy of the Somali donkey. *Amer. J. Physiol.*, 219(5), 1522–1527.
- Maloiy, G.M.O. and Boarer, D.H. 1971. Response of the Somali donkey to dehydration hematological changes. *Amer. J. Physiol.*, 221, 37–41.
- McCort, W.D. 1980. *The feral asses (Equus asinus) of Ossabaw Island, Georgia*. PhD thesis, Pennsylvania State University, Pennsylvania, USA. 219pp.
- Miller, R. and Denniston, R.H. 1979. Interband dominance in feral horses. *Z. Tierpsychol.*, 51, 41–47.

- Nelson, K.J. 1979. On the question of male-limited population growth in feral horses (*Equus caballus*). M.S. thesis. New Mexico State University, New Mexico, USA. 29pp.
- Moehlman, P.D. 1974. *Behavior and ecology of feral asses (Equus asinus), Death Valley, CA. USA*. PhD thesis, University of Wisconsin, Madison. 251pp.
- Moehlman, P.D. 1979. Behavior and ecology of feral asses (*Equus asinus*). Pp. 405–411 in: *National Geographic Society Research Reports*. 1970 projects. National Geographic Society.
- Moehlman, P.D. 1989. *The Status of the Somali wild ass (Equus africanus somaliensis) in the Nugaal Valley, Somalia*. Report to the Central Rangelands Development Program. Arusha, Tanzania. 9pp.
- Moehlman, P.D. 1994a. *The African Wild Ass: A survey of its current status in the Yangudi-Rassa National Park and the Southern Danakil, Ethiopia*. Report to the Ethiopian Wildlife Conservation Organisation, Addis Ababa, Ethiopia. 15pp.
- Moehlman, P.D. 1994b. *The African Wild Ass: A survey of its current status in the Dankelia Province, Eritrea*. Report to the Wildlife Department of Eritrea. Asmara, Eritrea. 7pp.
- Moehlman, P.D. 1998. Feral Asses (*Equus africanus*): Intraspecific variation in social organization in arid and mesic habitats. *Applied Animal Behavior Science*, 60(2, 3), 171–195.
- Moehlman, P.D., Kebede, F, and Yohannes, H. 1998. The African wild ass (*Equus africanus*): Conservation status in the Horn of Africa. *Applied Animal Behavior Science*, 60(2, 3), 115–124.
- Negarit Gazeta No.7, Legal Notice No. 416, (January 19, 1972). *Regulations issued pursuant to the Game Proclamation of 1944 and the Wildlife Conservation Order of 1970*. Addis Ababa, Ethiopia.
- Rowen, M. 1992. *Mother-Infant Behavior and Ecology of Grévy's Zebra, Equus grevyi*. Dissertation. Yale University, New Haven, CT. 159pp.
- Rubenstein, D.I. 1986. Ecology and sociality in horses and zebras. Pp. 282–302 in: *Ecological aspects of social evolution* (eds. D.I. Rubenstein and R.W. Wrangham). Princeton University Press, Princeton, New Jersey.
- Rubenstein, D.I. 1994. The ecology of female social behaviour in horses, zebras, and asses. Pp. 13–28 in: *Animal Societies Individuals, Interactions, and Organization* (eds. P.J. Jarman and A. Rossiter). Kyoto University Press, Kyoto.
- Schomber, H.W. 1963. Wildlife protection and hunting in the Sudan. Part I. *African Wild Life*, 16(2), 147–153.
- Simonetta, A.M. and Simonetta, J. 1983. An outline of the status of the Somali fauna and of its conservation and management problems. *Rivista di Agricoltura Subtropicale e Tropicale*, 73(4), 456–483.
- Stephenson, J.G. 1976. *The Somali wild ass (Equus africanus somalicus) in Ethiopia: A survey of its current status in the southern Danakil locality and recommendations on its conservation*. Report to the Ethiopian Wildlife Conservation Organization, Addis Ababa, Ethiopia. 22pp.
- Thouless, C.R. 1995. *Aerial surveys for wildlife in eastern Ethiopia*. Report to EWCO. Ecosystems Consultants, London. 30pp.
- Tomkiewicz, S.M., Jr. 1979. *Heterothermy and aater turnover in feral burros (Equus asinus) of the desert southwest*. MSc thesis, Arizona State University, Arizona, USA. 89pp.
- Tyler, S. 1972. The behavior and social organization of the New Forest ponies. *Anim. Beh. Monogr.*, 5(2), 1–196.
- Watson, M. 1982. *Draft report on the African wild ass*. Arusha, Tanzania. 5pp.
- Yalden, E.W., Largen, M.J., and Kock, D. 1986. Catalogue of the mammals of Ethiopia. Perissodactyla, Proboscidea, Hyracoidea, Lagomorpha, Tubulidentata, Sirenia, and Cetacea. *Italian Journal of Zoology*, 21(4), 31–103.
- Wolfe, M.L. 1980. Feral horse demography: A preliminary report. *J. Range Mangmt.*, 33(5), 354–360.
- Woodward, S.L. 1979. The social system of feral asses (*Equus asinus*). *Z. Tierpsychol.*, 49, 304–316.
- Ziccardi, F. 1970. The African wild ass. Part I. *Afr. Wildlife*, 24(3–4), 202–208, 287–292.