

A survey of the Endangered Barbary macaque *Macaca sylvanus* in the Central High Atlas Mountains of Morocco

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Abstract The Barbary macaque *Macaca sylvanus* is the only macaque in Africa. The species is categorized as Endangered on the IUCN Red List and is listed in CITES Appendix II. This macaque has a relict distribution in Morocco and Algeria. Recent studies have indicated a dramatic decline of Barbary macaque populations in the Middle Atlas and Rif Mountains in Morocco but there is limited available information on its distribution in the Central High Atlas. We therefore conducted interviews with local officials and inhabitants, and carried out field surveys in 12 sites from February 2004 to December 2008. We found Barbary macaques in relatively small and fragmented habitats in 10 of the 12 sites. A total of 35 groups were sighted and 644 individuals counted. Mean group size was 21 (range 6–42). In all surveyed sites habitat destruction and pressure from livestock were apparent. The interviews indicated that the macaques are often found in the proximity of agricultural land, and that there is evidence of illegal capture in the Bas Oued El Abid and Haut Oued El Abid areas. To protect this species we recommend establishment of protected areas specifically for the Barbary macaque, increased surveillance by forest guards, enforcement of the law against capture of the species, and education of the local people.

Keywords Barbary macaque, geographical distribution, High Atlas, *Macaca sylvanus*, Morocco

Introduction

The Barbary macaque *Macaca sylvanus* is categorized as Endangered on the IUCN Red List (Butynski et al., 2008) and is listed in CITES Appendix II (CITES Trade Database Report, 2011). It is the only macaque species that occurs beyond Asia (Fooden, 1982), and its current

distribution is limited to relict habitats in Morocco and Algeria (Taub, 1977; Fa et al., 1984; Camperio Ciani, 1986; Scheffrahn et al., 1993). A semi-wild population occurs in Gibraltar (Joleaud, 1931; Modolo et al., 2005; Perez & Bensusan, 2005). In the early 1980s the global population of Barbary macaques was estimated to be 14,000–23,000 (Fa et al., 1984). In the 1990s the population was 10,000–16,000 (Lilly & Mehlman, 1993; Von Segesser et al., 1999). The total Moroccan population is now estimated to be 5,000–6,000 (Waters et al., 2007; van Lavieren & Wich, 2009), a large decline since 2003, when the Moroccan population was estimated to be c. 10,000 (Camperio Ciani & Palentini, 2003). No recent data has been published on the status of the Algerian population. Between 65 and 75% of the surviving population occurs in the cedar *Cedrus atlantica* forests of the Middle Atlas (Taub, 1977; Camperio Ciani, 1986). In this area the density of macaques was estimated to be 44–70 km⁻² in the late 1970s (Deag, 1977; Taub, 1977; Fa et al., 1984) but recent studies indicate a dramatic decline (Camperio Ciani et al., 2005; Van Lavieren & Wich, 2009). In the Rif the population in the Djebela region decreased from 200 to 89 between 1980 and 2004 (Waters et al., 2007).

The main factors responsible for the decline of this species in Morocco are habitat destruction, the impact of livestock grazing, and illegal capture (Van Lavieren, 2004, 2008; Camperio Ciani et al., 2005; Waters et al., 2007; Van Lavieren & Wich, 2009). Limited information is available on the Barbary macaque distribution in the High Atlas. A few scattered groups occur in disturbed habitats in the Occidental High Atlas, and small fragmented populations were previously known to occur in the Central and Oriental High Atlas (Fa et al., 1984; Cuzin, 1996, 2003). The objective of this study was to determine the current status of the Barbary macaque populations in the Central High Atlas of Morocco, to describe any human–macaque conflicts and to make recommendations for the protection of the Barbary macaque in this area.

Study area

The study was conducted in the Central High Atlas of Morocco (Fig. 1). The terrain, mainly calcareous, consists of steep mountain slopes and rocky gorges dissected by swiftly running streams. Altitudes are 600–2,600 m. The region's climate varies from semi-arid to sub-humid (Emberger,

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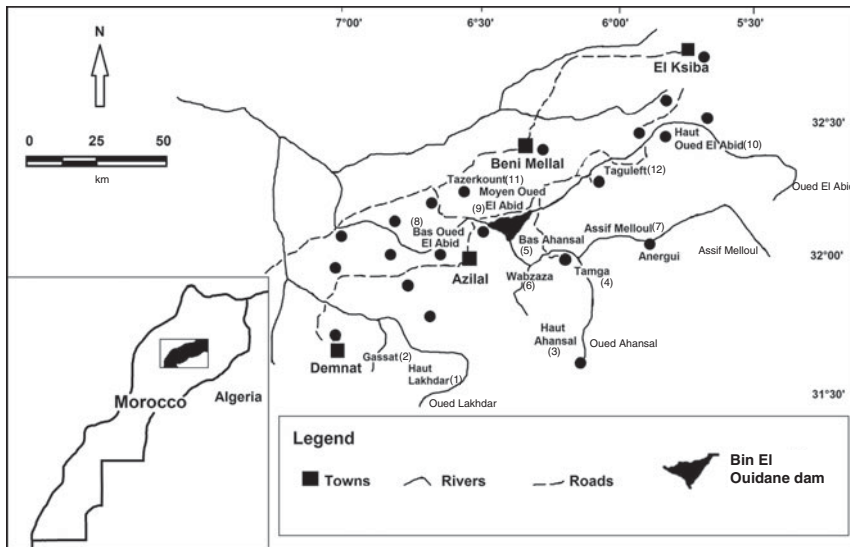


FIG. 1 The study area in the Central High Atlas, showing the locations of the sites (1–12; Table 1) where we surveyed for the Barbary macaque *Macaca sylvanus*, the four main valleys (Oued Lakhdar, Oued Ahansal, Assif Melloul and Oued El Abid), and the villages (black dots) in which the interviews were conducted. The rectangle on the inset indicates the location of the main map in Morocco.

TABLE 1 Locations, survey date, survey effort, total km surveyed, habitat type(s), number of groups sighted, mean group size and individuals counted of the Barbary macaque *Macaca sylvanus* in the central High Atlas of Morocco (Fig. 1) in 2004–2008. Protected sites are denoted by an asterisk.

Location (site in Fig. 1), by valley	Survey date	No. of surveys	Survey effort (days)	Total km surveyed	Habitat type	No. of groups sighted	Mean group size (range)	No. of individuals
Oued Lakhdar								
Haut Lakhdar (1)	Aug. 2006; Mar.–Apr. 2008	3	9	41	Open forest & non-wooded land	5	12 (6–28)	94
Gassat-Tifni (2)	Mar.–Apr. 2008	1	5	27	Open forest & non-wooded land	3		
Oued Ahansal								
Haut Oued Ahansal (3)	June 2007	1	4	18	Open forest	2	19 (7–37)	185
Tamga* (4)	Jan. 2006; Aug. 2007	2	7	35	Pine oak forest	3		
Bas Oued Ahansal (5)	Mar. 2006; Dec. 2007	4	14	43	Open forest	2		
Wabzaza* (6)	May 2005; Oct. 2007	3	21	38	Mixed forest	3		
Assif Melloul								
Assif Melloul (7)	May–June 2006; Mar. 2008	3	17	31	Thermophilous scrub (gorges & cliffs)	4	16 (7–26)	63
Oued El Abid								
Bas Oued El Abid (8)	Feb. 2004; Apr.–May 2006; Apr. 2008	6	13	18	Thermophilous scrub (gorges & cliffs)	4	23 (9–42)	302
Moyen Oued El Abid (9)	Sep. 2006; Feb.–Mar. 2007	5	18	38	Open oak forest	2		
Haut Oued El Abid (10)	Nov. 2006; Mar.–May 2007; Jan.–Mar. 2008	7	34	64	Mixed forest	7		
Tazerkount* (11)	Jan.–Feb. 2008	1	4	17	Oak forest	0		
Taguleft (12)	Jan. 2008	1	5	14	Open forest	0		
Total	2004–2008	37	151	384		35	21 (7–42)	644

1934, 1939; Sauvage, 1963). A description of the 12 surveyed sites is given in Table 1. The study area consists of non-wooded terrain, agricultural land, fragmented forests and brushwood. The main forms of land use are shifting agriculture and pastoralism. The habitat types in Sites 1, 2, 3,

5, 6, 8 and 9 are principally pure holm oak *Quercus ilex* or mixed with juniper (*Juniperus phoenicea*, *Juniperus oxycedrus* and *Juniperus thurifera*) and Barbary thuya *Tetraclinis articulata*. The forest located east of the town of Beni Mellal (Site 10) contains oak mixed with sparse cedars *Cedrus*

atlantica. Open forests of Aleppo pine *Pinus halepensis* occur in the valleys of Oued Ahansal and Assif Melloul (Sites 4 and 7).

Methods

In the Middle Atlas line transect surveys have been successfully used to estimate the densities of macaques (Camperio Ciani et al., 1996, 1999, 2005; Van Lavieren & Wich, 2009), and this is the most common method of censusing primate populations (e.g. Cant, 1978; Green, 1978; Glenn, 1998; Gonzalez-Kirchner, 1998; Wallace et al., 1998). However, the topography of the Rif and High Atlas Mountains is not conducive to such systematic surveys (Fa et al., 1984; Cuzin, 1996, 2003; Waters et al., 2007).

Therefore, we could not use distance sampling methods (Buckland et al., 2001, 2010) to estimate the density of macaques. We used a combination of standardized interviews combined with a direct count survey to gather information about the presence or absence of macaques in specific areas and to determine the relative abundance of the macaque in each site. Surveys took place between February 2004 and December 2008. These sites were previously known to have had macaque populations (Fa et al., 1984; Cuzin, 1996, 2003). The direct survey method entails counting individual animals or groups of animals. With the help of shepherds, who know the location of macaque groups in the areas where they graze their herds, macaque groups were identified and individuals counted.

Interviews were conducted from February 2004 to December 2008 with 15 officials of the Moroccan forestry department and a total of 119 inhabitants of 21 villages and of the towns of Beni Mellal, Azilal, Demnat, El Ksiba (Fig. 1), and in Ouauzezarht south of Bin El Ouidane dam. The questionnaire was administered in the local language (Tamazight) which is the first language of AE, RA and AC; in some villages the authors were known, motivating people to speak freely. We focused on shepherds and firewood collectors because of their knowledge of the environment in which they work. The local names of the Barbary macaque are *zaatout* and *lkard* in the Oued El Abid and the Oued Ahansal areas, *abagouss* and *lkard* in the Oued Lakhdar area, and *idoun* and *lkard* in the Assif Melloul area. Colour pictures of a chimpanzee and a Barbary macaque were shown and five questions were asked: (1) Did the interviewees recognize the Barbary macaque? (2) Are macaques present in the region? (3) Are macaques present year-round or seasonally? (4) Do macaques raid crops and cause damage? (5) Are macaques captured and/or killed in the region?

To search for and count macaques a team of 2–7 observers spent a total of 151 days surveying macaques in the 12 sites where the species had been reported. The number of kilometres surveyed and time spent surveying in a region is

summarized in Table 1. Before visiting sites we questioned people in nearby villages about their knowledge of Barbary macaques and existing paths. In particular we interviewed residents older than 40 years, shepherds and firewood collectors. Based on the information gathered we conducted surveys on foot. Observers (the authors and 2–5 local inhabitants) walked on pre-existing trails normally used by shepherds and other local people. The observers moved slowly and quietly along the path at a rate of 0.5–1.5 km h⁻¹, stopping periodically to watch and listen for macaques. Surveys took place from dawn to dusk. All the paths were mapped and their lengths calculated. Sightings of macaques, habitat quality, and presence of livestock were recorded during the survey. In these mountainous habitats the macaque groups were often spread over a large area and only a few individuals were visible. Except for the group at the tourist site of Ouzoud in the Bas Oued El Abid site (Site 8), the groups were not habituated to humans. The most common response of macaques to the approach of humans is to flee. This can be accompanied by vocalizations. Macaques are most often detected when moving, feeding or vocalizing. When a macaque group was observed the observers followed the group and chose the best place to obtain a count of individuals. For each group the individuals were counted either when they were in non-wooded land or when they crossed rivers or paths, using binoculars if necessary. Repetition of surveys, in combination with the location of the group sightings enabled us to differentiate individual groups.

Results

Seventy-one percent of the interviewed inhabitants recognized the picture of the Barbary macaque, and eight forestry officials and 52 inhabitants confirmed the presence of macaques at Sites 1–10 but not at Sites 11 (Tazerkount) and 12 (Taguleft). At Tazerkount four inhabitants indicated they had observed macaques in 1997 and showed two pictures of macaques on the road between Beni Mellal and Azilal. Information collected in the interviews also indicated that the capture of macaques occurs in Bas Oued El Abid (Site 8) and Haut Oued El Abid (Site 10). In all sites where macaques are present the interviewees mentioned that macaques come close to agricultural land and occasionally cause damage to crops.

The results of the surveys confirmed the information from the interviews and showed that the distribution of the Barbary macaque in the Central High Atlas is now restricted to 10 small areas in the main valleys (Oued El Abid, Oued Ahansal, Oued Lakhdar and Assif Melloul). We sighted a total of 35 groups and counted a total of 644 individual macaques. Mean group size was 21 with a range of 6–42 individuals (Table 1). The surveys confirmed that macaques do not occur in Tazerkount or Taguleft, or in the forest

downstream of the lake of Bin El Ouidane (part of Site 9), and in the mountains to the south of the town of Beni Mellal (also part of Site 9). Barbary macaques were observed in a wide range of habitats but 49% of the groups were seen in oak forests. Macaques were also found in areas containing junipers, Aleppo pine and Barbary thuya. One group lives in the tourist site of Ouzoud (part of Site 8) where macaques are habituated to humans and partly provisioned by food offered to them. We noted that in all places where we located macaques their habitat is subject to destruction and pressures from livestock. We frequently encountered fire-wood collectors or observed their permanent camps, and flocks of sheep and goats were always present in all surveyed sites. Only the most inaccessible forests of the reserves of Wabzaza (Site 6), Tazerkount (Site 11), Tamga (Site 4) and Bou Tferda (part of Site 10) were found to be still relatively intact and undisturbed.

Discussion

Ideally, our survey would have been carried out using distance sampling (Buckland et al., 2001, 2010). However, the survey sites were in many cases steep cliffs and other mountainous topography where it was not possible to delineate and walk transects. Furthermore, this topography makes it hard to detect macaques whilst they are fleeing and thus distances to groups or individuals are difficult to estimate. The fact that we surveyed at irregular intervals during 2004–2008 rather than within a more restricted period could have resulted in an overestimate of the macaque population in the Central High Atlas. However, the survey method that we used can provide information about changes in population status and patterns of human impact, and is thus sufficient for examining trends and defining management responses.

Our results concur with those of Fa et al. (1984) and Cuzin (1996, 2003) in indicating that in the Central High Atlas the Barbary macaque occurs in relatively small and fragmented areas restricted to the main valleys at altitudes of 700–2,400 m. Compared to these earlier studies, however, we found that the species no longer occurs in four localities. This could be attributed to habitat degradation, hunting activities, the impact of livestock grazing, and disturbance by people. As deforestation for agriculture and overgrazing continues, the remaining forest becomes increasingly fragmented. Consequently, the Barbary macaque is now restricted to small, fragmented relict habitats (Cuzin, 2003; this study).

Our study confirms earlier findings (Taub, 1977; Fa et al., 1984; Cuzin, 2003) that the Barbary macaque can occupy a wide range of habitats. We observed macaques in open and closed forests of oak, juniper, Aleppo pine, and Barbary thuya, in rocky mountain ridges, and at a tourist site. The

Barbary macaque is recognized for its adaptability, and is generally considered an eclectic feeder (Deag, 1974; Drucker, 1984; Mehlman, 1984; Ménard, 1985; Ménard & Vallet, 1986). Our surveys and Cuzin (2003) indicate that in the Central High Atlas this macaque appears to have a preference for oak and pine forests and is confined to inaccessible rocky slopes and gorges. The highest numbers of macaques were mostly found in protected sites; outside these the macaques were found in small numbers. Generally, the sizes of the groups sighted were small and group size was highly variable. The Barbary macaque can be used as a biological indicator of forest quality (Mouna et al., 1999; Camperio Ciani et al., 1999, 2001; Camperio Ciani & Palentini, 2003), and the demographic differences between the populations living in different habitats are the results of deforestation, overgrazing and human interferences (Mehlman, 1989).

The conservation of Barbary macaque requires assessing the quality of remaining habitats and evaluating the impacts of human influences. Increasing human activity has enhanced the opportunities for contact between people and the macaques. Consequently, the damage caused to crops by macaques is escalating and macaques have become victims of trapping for the pet trade. We recommend four measures to reduce the likelihood of this Endangered species of macaque becoming extinct in the Central High Atlas of Morocco: (1) establishment of protected areas specifically for the species in locations where it is extant, (2) increased surveillance by forest guards, (3) enforcement of the existing law against illegal capturing of macaques, and (4) education to raise the awareness of the local people about the Barbary macaque. These measures are detailed in the National Conservation Action Plan for the Barbary macaque in Morocco, which was finalized in November 2012.

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