

Geographic distribution and population size of the Barbary macaque (*Macaca sylvanus*) in Algeria

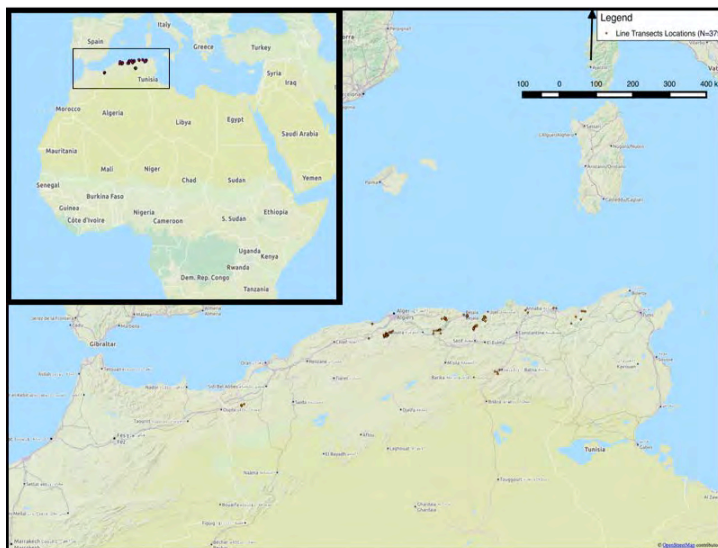
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Macaca sylvanus is the only surviving macaque species remaining in Africa. Historically it had an expanded geographical distribution across Europe and Asia. Currently the species is classified as 'Threatened' (IUCN, 2012) and is limited to remnant forest patches in Algeria and Morocco. Recent studies from Morocco have shown a significant decline in distribution, indicating a population size decline from an estimated 14,000-23,000 to 5,000-6,000 individuals (Van Lavieren & Wich 2009; Waters et al., 2007). The main factors contributing to the population decline in Morocco are habitat loss and human disturbance (i.e. deforestation, livestock overgrazing) and illegal capture for the pet market.

The aims of the study were: 1) To assess the current population status of the Barbary macaque in Algeria; and 2) To estimate the presence, size and distribution of areas potentially suitable for, but not currently inhabited by, Barbary macaques in order to design a reintroduction programme in collaboration with the Algerian authorities. My study comprised two separate field seasons; the first survey lasted from September 8th 2013 to January 4th 2014, for a total of 194 days. The second field season, aided by the PSGB/BFF grant, lasted 165 days, between June 1st and September 15th 2015. This study was conducted under the supervision of Drs. Malgorzata Pilot and Bonaventura Majolo. Field sites were selected based on the previous population survey conducted by Taub (1977). I gathered additional historical accounts (reviewed in Taub, 1977), and observation from local people to include new areas not previously surveyed. The surveyed regions were: Ait Alouane, Akfadou, Babors, Bejaia, Belezema, Djurdurja, Draguina, M'sila, Gorge Chiffa, Gouraya, Guerrouch, Kala, Kharratta, Pic de Singes, Taza, Tlemcen, Tikjda, Toujda and Yakouren (Figure 1). As such, our study is the most comprehensive survey of the Barbary macaques in Algeria conducted so far.



I used the line-transect methodology to estimate presence of the macaques and population size at the different locations. A total of 351 linear 1000 m long transect surveys were conducted over 21 locations. Transect surveys were repeated for an average of 12.3 times for each study site and distributed across the two field seasons trying to have at least one survey run in each of the four seasons and site. Primate observations were collected by a single observer, on both sides and recorded perpendicular to the transect line. To minimize stress on wildlife, equipment was covered with earth tone covers and observers wore earth tone clothes.

Figure 1. Map of the study sites in Algeria in which surveys were conducted.

The second season was instrumental to data collection for the application of a range of analysis tools to help answer a critical knowledge gap. The last population survey was conducted 30 years ago and estimated the Algerian population of macaques to be between 4150-5850 individuals (Taub, 1977; Fa et al., 1984). In this study I surveyed the current population size and distribution, and modelled habitat availability for the Barbary macaque in Algeria across 21 sites (Figures 2, 4 and Table 1). The population was estimated to be 1500-3500 individuals, suggesting a decline of 30%. The results of this study have been included by Algerian and international organizations for future conservation measures and programmes for the species in Algeria. An Algerian Plan for Conservation of the Barbary Macaque has begun in response to the study outcomes.

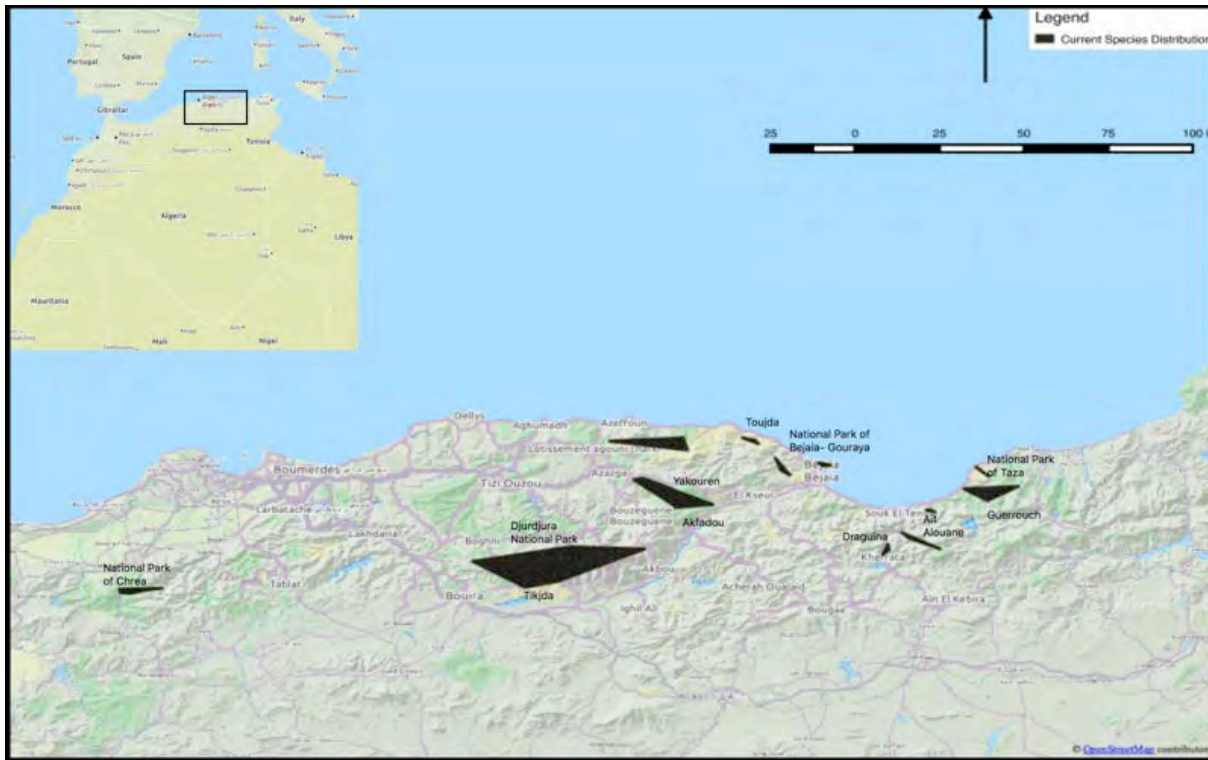


Figure 2. Distribution of Barbary macaques in Algeria based on our current study.



Figure 3. Barbary macaques in the study site

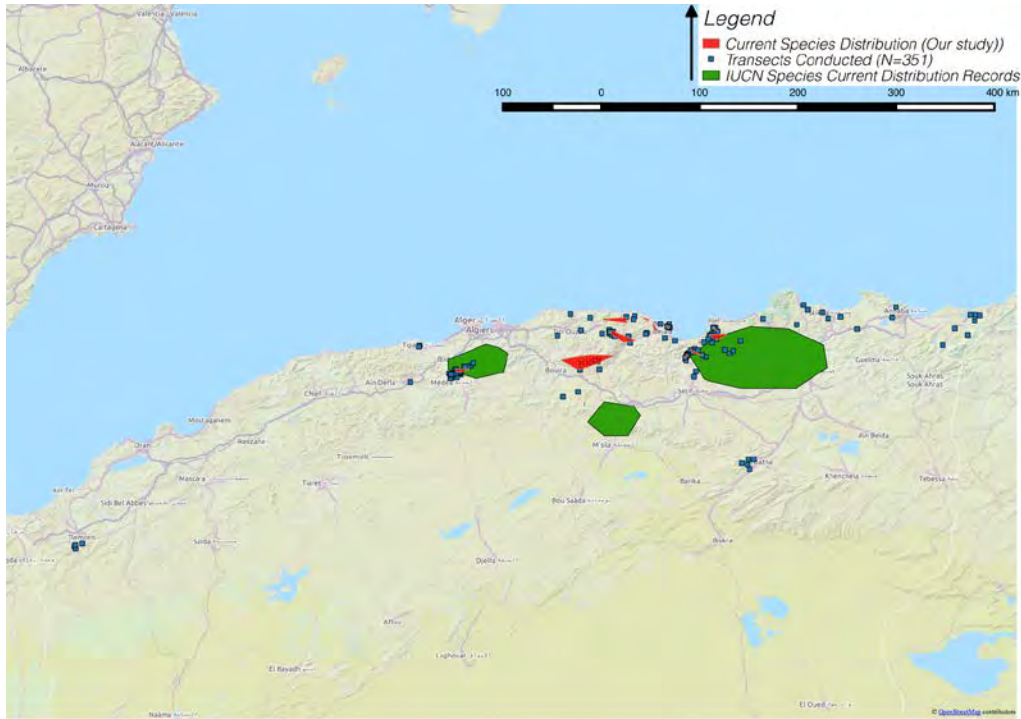


Figure 4. Map of the study sites in Algeria in which transect surveys were conducted (N=351) over 21 study sites and the current distribution of Barbary macaques in 2015 in comparison with the IUCN records.

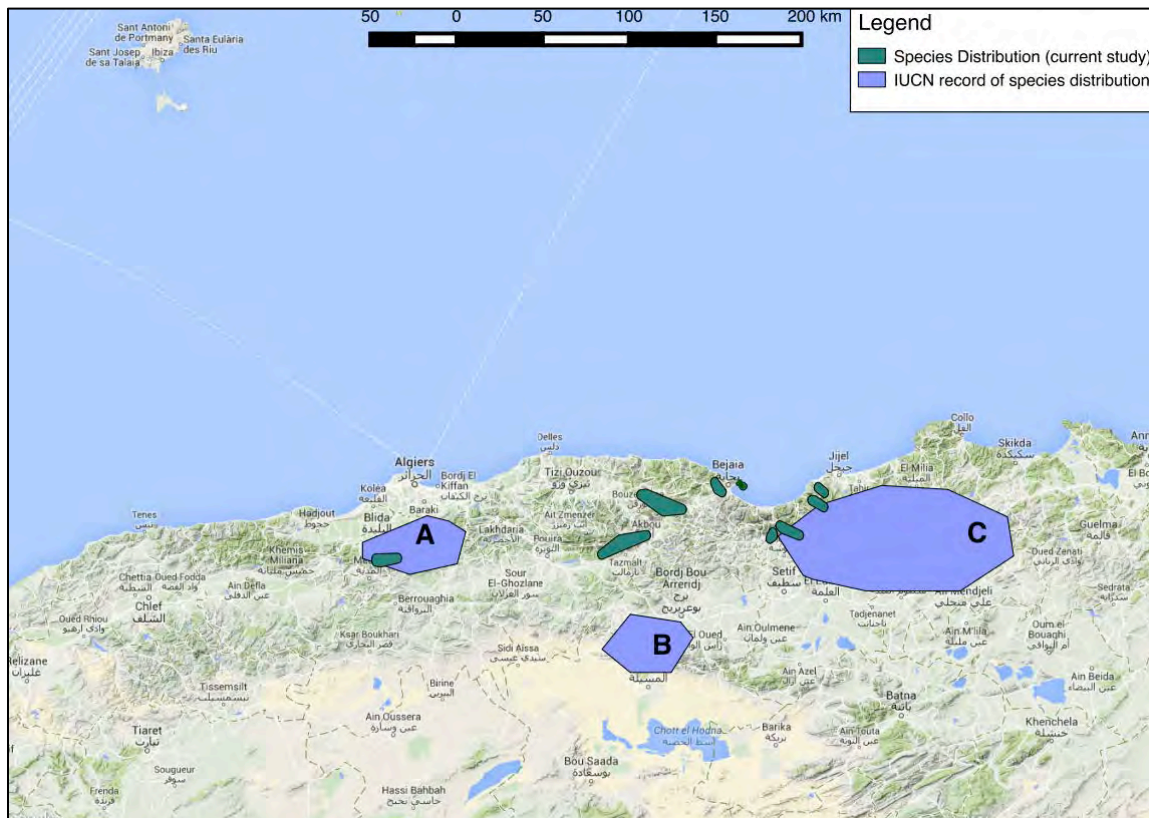


Figure 5. Map showing the locations of Barbary macaques in Algeria based on this study (in green) and IUCN spatial distribution data of Barbary macaques, as available for download (IUCN, 2012). The purple coloured regions, marked A, B and C, are IUCN records of distribution.

Table 1. Comparing results of two surveys (in 1986 and 2015) examining the geographic distribution of Barbary macaques within Algeria. *Historic literature on species presence in this location is unclear or absent. ^aInformation from Taub, 1977; Fa et al, 1984; ^bThis study - 2015

Location	Past occurrence^a	Current occurrence^b
WEST		
National Park of Chrea	Y	Y
Tlemcen	*	N
Msila	*	N
CENTRAL		
Forests of Akhfadou	Y	Y
National Park of Djurdjura (PND)	Y	Y
Tikjda (PND)	Y	Y
Forests of Yakouren	Y	Y
EAST		
Belezema	*	N
Bejaia, National Park of Bejaia-Gouraya (PNBG)	Y	Y
Draguina	*	Y
Gouraya (PNBG)	Y	Y
Guerrouch (NPT)	Y	Y
Kala (Kala National Park)	*	Y
Kharrata	Y	Y
Toujda *	*	N
Pic De Singes (PNBG)	Y	Y

I used QGIS (<http://qgis.org/api/index.html>) (QGIS Development Team, 2014) freeware to input GPS points, and applied raster and vector analysis tools to visualize the study site areas, geographical distribution and habitat modelling variables. I used EPSG:4326 WGS84 and Pseudo Google Mercator projection on open source maps from NaturalEarth, OpenStreetMap, Google and Google satellite. I also modelled habitat suitability based on the characteristics of currently occupied areas to investigate past, present and future regions of habitat suitable for protection to preserve the species (Figure 6). Current and near future climatic changes are modelled to show what suitable habitat is or will be available for Barbary macaques. The presence of human disturbance activities were recorded in all Barbary macaque habitats surveyed.

I provided data to update and maintain accurate information about the endangered species for future conservation, research and protection programmes. I presented adjustments to the IUCN Red-List African Mammal Species Committee for the consideration of the database update of the wild Barbary macaques for the IUCN Red List page: <http://www.iucnredlist.org/details/12561/0>. I found a large geographical discrepancy between the current species distribution and the current IUCN maps (Figure 5). This is important to consider for a variety of reasons; in particular future conservation efforts of this red-listed species may be allocated to areas with no macaques present. Furthermore, inaccurate data about the species' distribution may be used in other studies, e.g. assessing biodiversity in North Africa.

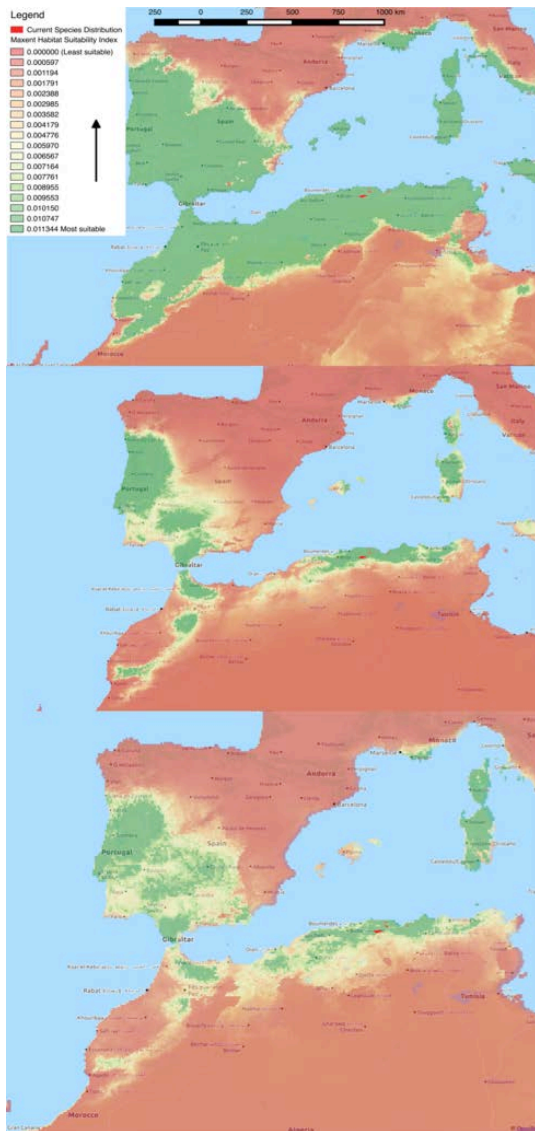


Figure 6. Areas suitable for Barbary macaques. Prediction strength is shown as red (weakest) to green (strongest); greens could be interpreted as suitable conditions for the species in three separate time periods; A. Mid-Holocene (≈ 6000 ybp), B. Current projection models (1950AD-2000AD) and C. Future projection (2050AD-2100AD).

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