

## **Status, threats and conservation of native carnivores in the M’Goun UNESCO Global Geopark, central High Atlas, Morocco**

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### **Abstract**

The M’Goun Geopark is the first geopark of Morocco, Africa and the Arab world. It constitutes the major part of the central High Atlas and it has a rich and varied geological and biological diversity. The objective of this study was to determine the current status of the mammalian carnivore species in this area and to propose recommendations for the protection of the threatened species. Results showed that at the end of the 20th century, the carnivores were represented by 11 species in the study area and one species, the Barbary Lion, was extirpated during 1930s and 1940s. Although 72% of the carnivore species of the central High Atlas are not threatened by extinction in their global range, 54% of them are threatened in Morocco. Results of interviews showed that 100% of the interviewees confirmed the panther and the serval were extirpated from this area and the majority of the interviewees confirmed that the Egyptian mongoose and the striped hyena were extirpated too. Results also showed that the common genet becomes rare, the Eurasian otter and the wild cat become less abundant, and only the golden jackal, the African wolf, the red fox and the least weasel are still relatively abundant. Results showed that there is an increasing in the local people-carnivore conflict. The extinction and decline of the carnivore species have negative impacts on ecosystems and on economical activities of local people. To conserve native carnivores of the central High Atlas, urgent measures may need to be taken.

**Keywords:** Biodiversity, carnivores, central High Atlas, species extinction, human-wildlife conflict, conservation.

### **Introduction**

The conservation of biodiversity is now a national concern in Morocco. Actually there is an increasing decline of biodiversity due to natural and anthropic factors. Many species have become extinct and others were at risk of extinction. Among the extinct species in Morocco we can cite the Atlas lion *Panthera leo* (Cabrera, 1932), the hartebeest *Alcelaphus buselaphus* (Panouse, 1957), the addax *Addax nasomaculatus* (Heim De Balsac, 1948) and the scimitar oryx *Oryx dammah* (Valverde, 1957). Other species have become rare such as the panther *Panthera pardus*, the cheetah *Acinonyx jubatus*, the caracal *Caracal caracal* and the serval *Leptailurus serval* (Cuzin, 1996, 2003).

Several other mammals become less abundant such as the striped hyena *Hyaena hyaena*, the crested porcupine *Hystrix cristata*, the Barbary sheep *Ammotragus lervia* and the Cuvier's gazelle *Gazella cuvieri* (Maghnouj, 1999, El Alami, 2019a). Wild mammals of Morocco are known mainly through the work of Trouessart (1905), Cabrera (1932), Joleaud (1934), Heim De Balsac (1948), Brosset (1960), Aulagnier & Thévenot (1986), Bayed & Beaubrun (1987), Aulagnier (1992), Cuzin (1996, 2003), Aulagnier *et al.* (2015), El Alami (2016, 2019a,b), and El Alami *et al.* (2013, 2020).

The central High Atlas has a great diversity of habitats and of plant and

animal species (El Alami *et al.*, 2013; El Alami, 2016; El Alami & El Alami, 2018). This area is home to a variety of animal species, especially mammals with more than 24 wild mammal species (Cuzin 2003, El Alami 2016). Since the beginning of 20th century, habitats were subject to destruction and pressures from human activities, consequently many species were extinct. In this area, there were the last observations of several carnivore species in Morocco as the case of the serval (1966: Lambert 1967), the panther (1983: Cuzin 2003) and the Barbary lion (1942: Black *et al.*, 2013). The M'Goun UNESCO Global Geopark is located in the central High Atlas and it constitutes the major part of

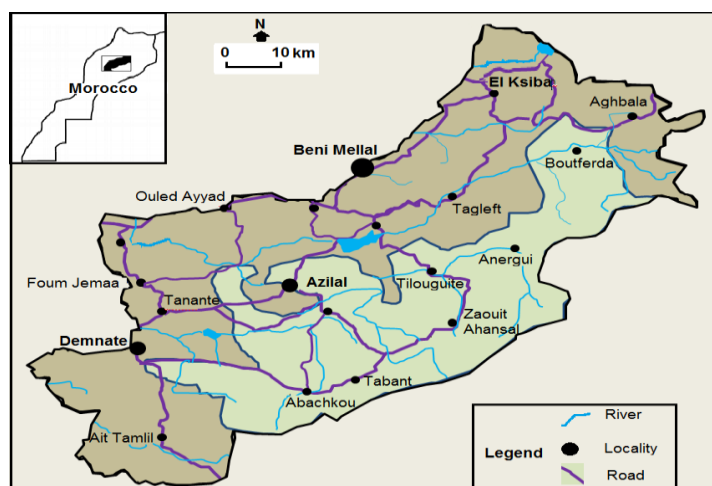
these mountains. This geopark includes famous and spectacular footprints of sauropod and theropod dinosaurs and many deposits of bones and has a very geological interest. The M'Goun Geopark also has a rich and varied biological diversity and it contains several mammal species including several wild carnivores. In this area, the status of the wild mammalian carnivore is far from clear and there is limited available information on their distribution and ecology. The objective of this study was to determine the current status of the mammalian carnivore species in the study area and to propose recommendations for the protection of the threatened species.

## Materials and methods

The M'Goun Geopark (31°30'00"N, 06°27'00"W) constitutes the major part of the central High Atlas (Figure 1). It is the first geopark of Morocco, Africa and the Arab world. It covers an area of 12 791 km<sup>2</sup> including 5 730 km<sup>2</sup> labeled "Unesco Global Geopark" by UNESCO in September 2014 (UNESCO Global Geopark, 2017). It encompasses 15 municipalities (Azilal, Demnate, Tilouguite, Zaouit Ahansal, Tabant, Ait M'Hamed, Ait Taguella, Agoudi N'lkheir, Ait Abbas, Ait Boulli, Ait Blal, Sidi Boulkhelf, Tifni, Anergui, and Boutferda). The geological heritage of the Geopark includes outstanding mine-

ralogical and paleontological features, like abundant dinosaur trackways of theropods and sauropodes, geomorphologic sites like the Jurassic limestone bridge Pont d'Imin Ifri, or waterfalls, and impressive conglomerate cliffs (UNESCO Global Geopark, 2017). Altitudes range between 600 and 4 071 m.

The study area has a Mediterranean climate with four distinct seasons: winter, spring, summer, and autumn (Ouchbani & Romane, 1995). Temperatures range from 5.9 °C (in winter) to 40.3 °C (in summer) (Sauvage, 1963). The study area is characterized by diverse land use practices that included natural vegetation



**Figure 1.** The M'Goun Geopark map showing the main rivers, roads and localities. The rectangle on the inset indicates the location of the study area in Morocco.

and agricultural surface. The following plant species were common in the study area are *Ziziphus lotus*, *Acacia gummifera*, *Ceratonia siliqua*, *Rhus pentaphylla*, *Withania frutescens*, *Euphorbia resinifera*, *Genista* spp., *Quercus ilex*, *Juniperus phoenicea*, *Juniperus oxycedrus*, *Pistacia lentiscus*, *Phillyrea* spp., *Arbutus unedo*, *Tetraclinis articulata*, *Pinus halepensis*, *Quercus suber*, *Juniperus thurifera*, *Erinacea anthyllis*, *Bupleurum spinosum*, *Alyssum spinosum*, *Cytisus balansae* and *Artemisia* spp. (El Alami *et al.*, 2013; El Alami, 2019a, 2019b). The M'Goun Geopark is a protected territory which includes 22 geosites of exceptional interest and these mountains also contains eight sites of biological and ecological interest: 1. Wabzaza (31°57' N-06°20' W), 2. Ouzoud (32°00' N-06°44' W), 3. Imi n'Ifri (31°43' N-06°58' W), 4. Tamga (31°55'-32°02' N-06°03'-06°12' W), 5. Bou Tferda (32°15' N-05°55' W), 6. Assif M'Goun (31°30'31" N, 6°26'39" W), 7. Haut Oued Lakhdar (31°50' 85"N 07°5'31" W), and 8. Assif Ahançal-Melloul (31°59'55"N 06°07'54"W).

Data on the native carnivore species were collected between January 2015 and May 2021. In this study, we used a combination of standardised interviews, and the “presence/ absence” method combined with the direct survey method to gather information about the carnivore species in the M'Goun Geopark territory. During surveys, new information was collected about the carnivore species living in the study area. Based on information gathered through interviews we conducted surveys. Due to the mountainous topography it was not possible to delineate and walk transects or to conduct systematic field surveys. Together with assistants we conducted 28 surveys in all sites where the presence of the carnivore species was reported. Direct method (observation) and indirect method (signs of carnivore presence) were used to gather information about the “presence/ absence” and the abundance of each carnivore species.

Interviews were carried out by the use of questionnaires among the boarded villages around forests in the study area. A total of 400 local people participated in the survey. The sample consists of 86 % of men. The percentage of the adults aged of 16-50 years is higher in the sample. The level of education is poor in the sample and the major occupations of the interviewees are shifting agriculture and pastoralism. The focus was on shepherds and firewood collectors. Interviews were administered in the local language (Tamazight) which is the first language of the first author. Interviews were about the carnivore species living actually in the region and the species which have disappeared. We asked the interviewees about the abundance of each species (very abundant, abundant, less abundant, rare, very rare, and extinct) and about the last observation of each carnivore species. Question about disadvantages of the presence of the wild carnivores and about the capture or killing of these predators were asked. The local name of each species was noted and colour pictures of carnivores were shown. At the end of the interview, we conducted a general discussion with each interviewee about the wild carnivores, especially about their ecological roles, their importance in the encouragement of tourism and about the importance of the conservation of these animals. We have classified the native carnivore species according to their IUCN status and to their national status. The national status of each species was established based on the works of Cuzin (1996, 2003). The IUCN Red List is the world's most comprehensive record on the conservation status of species. The IUCN Red List criteria are based on biological factors related to extinction risk and include rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation. Species are classified by the IUCN Red List into nine groups: Extinct (EX), Extinct in the Wild (EW), Critically En-

dangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least

Concern (LC), Data Deficient (DD) and Not Evaluated (NE) (IUCN, 2020).

## Results

At the end of the 20th century, the carnivores were represented by 11 species in the M'Goun Geopark territory and one species, the Barbary Lion, was extirpated during 1930s and 1940s (Table 1). Today this species live in captivity such as in the Rabat Zoo in Morocco (Figure 2). Among the 11 species, one species, the panther, is listed as 'Vulnerable', two species, the striped hyena and the Eurasian otter, are listed as 'Near Threatened', and eight species, the golden jackal, the African wolf, the red fox, the wild cat, the serval, the Egyptian mongoose, the least weasel, and the common genet are listed as 'Least Concern' in IUCN's Red List of Threatened species (Table 1). Although 72% of the carnivore species of the central High Atlas are not threatened by extinction in their global range, 54% of them are threatened in Morocco. The panther is listed as 'Critically Endangered', the serval and the striped hyena are listed as 'Endangered', the Eurasian otter and the golden jackal are listed as 'Vulnerable', the wild cat is listed as 'Near Threatened' in the national status (Cuzin, 1996, 2003) (Table 2). The African wolf was not evaluated by this author and the other four species have a 'Least Concern' national status (Table 2).

Results of 400 interviews over five years showed that 100% of the interviewees confirmed that the panther and the serval (Figure 3) were extirpated from the M'Goun Geopark territory during the last decades of the 20th century and the majority of the interviewees confirmed that the Egyptian mongoose and the striped hyena (Figure 4) were extirpated too (Table 2). Results also showed that the common genet becomes rare, the Eurasian otter and the wild cat become less abundant, and only the golden jackal, the African wolf, the red fox and the least weasel are still relatively abundant

(Table 2). Results of the surveys confirmed the information from the interviews. Over five years, we did not find any signs of the presence of the panther, the serval, the Egyptian mongoose and of the striped hyena in the study area. The golden jackal, the wild cat, the Eurasian otter, and the common genet become less abundant and their presence is restricted to few sites (1-3 sites). Only the African wolf, the Red fox and the least weasel were detected in several sites (4-8 sites). The last observation of the extinct and current carnivore species the study area are given in the table 2. During the two last years (2020-2021), we observed the *Canis* spp., *Vulpes vulpes*, *Felis silvestris*, *Mustela nivalis*, *Lutra lutra*, and *Genetta genetta* in the central High Atlas. Interview results showed that the majority of the interviewees confirmed that the presence of wild carnivores near their villages is unfavourable and that the predation of livestock is the main cause of negative attitudes toward these predators. The carnivore species most frequently reported for predation of domestic animals by the interviewees were the African wolf and the



**Figure 2.** The Barbary Lion in the Rabat Zoo, Morocco (Photographed by Ilyas El Alami, August 21, 2017).

golden jackal (59% of the interviewees), followed by the red fox (36% of the interviewees) and the common genet (17% of the interviewees). Some inhabitants

have shown us the carcass of individuals of the African wolf, the red fox and of the

common genet killed by local people in the study area (Figures 5 and 6).

**Table 1.** Native wild carnivores of the M'Goun Geopark territory: family, names, and IUCN status (EW: Extinct in the Wild, EN: Endangered, VU: Vulnerable, NT: Near Threatened, LC: Least Concern, and NE: Not Evaluated).

Order	Family	Common name	Local name	Scientific name	IUCN status
Carnivores	Canidae	Golden jackal	Ouchen	<i>Canis aureus</i>	LC
		African wolf	Ouchen /Dib	<i>Canis lupus lupaster</i>	LC
		Red fox	Ahaliw, Aâlboun	<i>Vulpes vulpes</i>	LC
	Felidae	Wild cat	Mouch n'Lakhla	<i>Felis silvestris</i>	LC
		Panther	Aghalyass	<i>Panthera pardus</i>	VU
		Barbary lion	Izm	<i>Panthera leo leo</i>	EW
		Serval	-----	<i>Leptailurus serval</i>	LC
	Herpestidae	Egyptian mongoose	Sbsab	<i>Herpestes ichneumon</i>	LC
	Hyaenidae	Striped hyena	Ifiss	<i>Hyaena hyaena</i>	NT
	Mustelidae	Least weasel	Tathka, Fart Alkhil	<i>Mustela nivalis</i>	LC
		Eurasian otter	Iydi n'Waman	<i>Lutra lutra</i>	NT
	Viverridae	Common genet	Tasaghda	<i>Genetta genetta</i>	LC

**Table 2.** National status and abundance of the native carnivore species in the M'Goun Geopark territory (EW: Extinct in the Wild, CR: Critically Endangered, EN: Endangered, VU: Vulnerable, NT: Near Threatened, LC: Least Concern, and NE: Not Evaluated).

Family	Species	National status	Abundance in the CHA (% of interviewees)	Last observation in the CHA (locality, reference)
Canidae	<i>Canis aureus</i>	VU	Abundant (72%)	2021 (Bni Ayat and Agoudi n'Lkhir, this study)
	<i>Canis lupus lupaster</i>	NE		
	<i>Vulpes vulpes</i>	LC	Abundant (81%)	2021 (Bni Ayat, this study)
Felidae	<i>Felis silvestris</i>	NT	Less abundant (69%)	2020 (Agoudi n'Lkhir, this study)
	<i>Panthera pardus</i>	CR	Extinct (100%)	1983 (Boutferda, Cuzin 2003)
	<i>Panthera leo leo</i>	EW	Extinct (100%)	1942 (Tizi n'Tichka, Black <i>et al.</i> , 2013)
	<i>Leptailurus serval</i>	EN	Extinct (100%)	1966 (Bin El Ouidane, Lambert 1967)
Herpestidae	<i>Herpestes ichneumon</i>	LC	Extinct (93%)	2000 (Bin El Ouidane, Cuzin 2003)
Hyaenidae	<i>Hyaena hyaena</i>	EN	Extinct (96%)	2004 (Aghbala, this study)
Mustelidae	<i>Mustela nivalis</i>	LC	Abundant (67%)	2020 (Agoudi n'Lkhir, this study)
	<i>Lutra lutra</i>	VU	Less abundant (91%)	2021 (Oum Er Bia River, this study)
Viverridae	<i>Genetta genetta</i>	LC	Rare (59%)	2021 (Agoudi n'Lkhir, this study)





**Figure 3.** The panther and the serval in the Rabat Zoo, Morocco (Photographed by Ilyas El Alami and Ziad El Alami, August 21, 2017).



**Figure 4.** Preserved specimen of the striped hyena in the Scientific Institute of Rabat (Photographed by Abderrazak El Alami).



**Figure 5.** The authors examine a carcass of the African wolf killed by inhabitants in the central High Atlas of Morocco (Bni Ayat-Ait Attab region, 2021).



**Figure 6.** A Carcass of the common genet killed by inhabitants in the central High Atlas of Morocco (Agoudi n'Lkhir region, 2021).

## Discussion and conclusion

The order of the carnivores was the most varied order of mammals in the in the M'Goun Geopark territory, central High Atlas until the end of 20th century (Cuzin, 2003; El Alami, 2016). Results of this study showed that the panther and the

serval were extirpated from this area and the Egyptian mongoose and the striped hyena are extinct or on the verge of extinction. The other carnivore species living today in the study area are threatened by overhunting. In the central High

Atlas, the effect of human on carnivore populations is among the major problems responsible of the decline of carnivore species and the human-carnivore conflict may act as factors in the decline of carnivore populations (Cuzin 2003, El Alami 2016, El Alami *et al.*, 2020). In this area, the carnivore species are threatened by overhunting, habitat destruction, a highly fragmented population and the risk of local extinction (Cuzin 1996, 2003). The predation of livestock is the main cause of the local people-carnivore conflict and of negative attitudes toward these animals. The extinction and decline of the carnivore species have negative impacts on ecosystems and on economical activities of local people (LeFlore *et al.*, 2019). For example, the increase in the wild boar populations in this area is due mainly to the extinction and decline of their main predators, especially, the panther, the *Canis* species and the red fox (El Alami 2019b). This study showed that the wild boar has negative impacts on natural ecosystems and cultivated flora of the central High Atlas (El Alami 2019b).

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To conserve native carnivores of the M'Goun Geopark, urgent measures may need to be taken. The rural community development projects revive local economies and supports efforts to conserve biodiversity. It is important to involve residents to use some non-lethal techniques to protect livestock and to keep carnivores away, such as a livestock guard dogs and monitoring and pasturing of livestock. Education to raise the awareness of the local people about the ecological and economical roles of wild carnivores can involve inhabitants, local authorities and associations in the surveillance of the native carnivore species and of local habitats. We also note the existence of many local and artisanal products with a strong territorial link and a real potential for economic development in the central High Atlas. For example more than 80 medicinal plants, used for medicinal purposes in Morocco and worldwide, grow spontaneously in these mountains (El Alami *et al.*, 20116; El Alami and Chait, 2017).

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