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Cover Photo: From top left to bottom right:
Caspian tiger (K. Rudloff)
Asiatic lion (P. Meier)
Asiatic cheetah (ICS/DoE/CACP/Panthera)
caracal (M. Eslami Dehkordi)
Eurasian lynx (F. Heidari)
Pallas's cat (F. Esfandiari)
Persian leopard (S. B. Mousavi)
Asiatic wildcat (S. B. Mousavi)
sand cat (M. R. Besmeli)
jungle cat (B. Farahanchi)

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Baseline information and status assessment of the Pallas's cat in Iran

Iran is most likely the western boundary of the Pallas's cat's, or manul *Otocolobus manul* global distribution range. The Pallas's cat is amongst the least-studied felids in Iran and basic questions about its status and natural history have yet to be answered. Our review of the available information suggests significant increases in the range of the species previously known from Iran. North-eastern Iran remains a hotspot of Pallas's cat occurrence in the country, but there are a growing number of recent confirmed records from southern slopes of Alborz Mountains, as well as the south-central provinces. Human disturbances such as mining activities and traditional pastoralism, particularly during summer when alpine and sub-alpine rangelands are occupied by flocks of livestock, might have adverse impact on the Pallas's cat. The lack of scientific understanding of the Pallas's cat in Iran restricts our ability to conserve the species.

The Pallas's cat is a short-legged small cat, approximately the same size as a domestic cat, with a broad distribution through semi-arid and arid steppes of Russia and China to the Caspian Sea region in western Asia. Being considered as one of the least-studied carnivores of Iran, very little verifiable information is present about the natural history and aspects of ecology of the Pallas's cat in the country. The need to identify the current distribution and status of the Pallas's cat is urgent in order to direct future research to understand the species' conservation needs. In this study, we present a review of the current state of the species' biology and geographical distribution range in Iran as recorded in the last 25 years, as comprehensive as possible, and discuss potential threats in the Iranian range of the Pallas's cat.

Methods

Our study approach was similar to the one described in details in Moqanaki et al. (2010). In brief, we undertook a synthesis of the Pallas's cat in Iran using published reports, unpublished accounts, museum specimens, and extensive interviews and interrogations with trained Iranian biologists, provincial wildlife authorities, taxidermist, and hunters. We updated this information during two participatory workshops facilitated by Iran Department of Environment DoE, University of the Environment, and IUCN/SSC Cat Specialist Group, in Karaj, Alborz Province (27-29 November 2011) and Sari, Mazandaran Province (12-14 May 2012). Following our earlier work, we filtered and refined the unpublished data based on their reliability and categorised them into three groups of: 'historical': confirmed records of presence obtained before 2000; C1: confirmed records with physical evidences (e.g. photos, videos, carcasses, museum specimens with identified origins); C2: reliable field observations verified by either us or a trained person. Unlike Moqanaki et al. (2010), we did not find the C3 category applicable to our Pallas's cat records, because we felt that the remaining unconfirmed records are too ambiguous given our criteria.

Fig. 1. A Pallas's cat photo-trapped in Salouk National Park, North Khorasan Province, in fall 2015 (Photo M. S. Farhadinia/WildCRU/ICS/Panthera).

Description and taxonomy

Adult manuls, the species' other popular name, weigh 2.5-5.3 kg and the average body length is approximately 55 cm (Sunquist & Sunquist 2002, S. Ross, unpubl. data). The Pallas's cat has a heavy fur coat of silvery to rufous-grey and faint stripes on the body (Fig. 1). Short-rounded ears and large eyes are set on a flattened broad face. Distinctive dark stripes adorn the face and cheeks and the head is decorated with small spots. A spectacle-like pattern circles the eyes. The tail is bushy and banded with narrow stripes, with a dark tip at the end. The coat coloration may appear darker in spring-summer (Nowell & Jackson 1996, Sunquist & Sunquist 2002).

We obtained 16 measurements from the Iranian Pallas's cats (Supporting Online Material SOM T1). On average, Iranian specimens weigh 2.4 ± SE 0.1 kg (male: 2.5 ± SE 0.2 (n = 8) vs. female: 2.3 ± SE 0.1 (n = 6)). Furthermore, head and body length reaches 55.5 ± SE 1.1 cm with a mean tail length of 25.5 ± SE 0.4 cm for Iranian Pallas's cats.

The taxonomic status of the Pallas's cat was unclear until very recently. At first, on the basis of the coat appearance, Peter Simon Pallas postulated that the manul is a likely ancestor of Persian domestic cat breeds (Nowell & Jackson 1996). Later authors classified the species as *Lynx*, *Felis*, and subsequently in its own genus. Today, *Otocolobus* is believed to be a monotypic genus. Novel molecular studies have suggested a very close phylogenetic relationship with the *Prionailurus* lineage (Johnson et al. 2006). Three subspecies are proposed to date: *O. m. manul* (Pallas 1776) in Russia, Mongolia and northern China; *O. m. nigripectus* (Hodgson 1842) on the Tibetan Plateau and probably Kashmir; and *O. m. ferrugineus* (Ognev 1928) from Central Asia to Iran. While the eastern subspecies is the typical greyish morph, the western population shows a variably rufescent coat colour (Nowell & Jackson 1996; see Figs. 1-3).

Otocolobus manul

Names:
گربه پالاس Gorbe-ye-Palas
Pallas's cat (manul)

Head and body length:
48-60 cm
Tail length:
23-29 cm
Weight:
1.5-3.7 kg

Global Population:
Unknown
Iranian Population:
Unknown

Distribution in Iran:
Mainly north-east and north outside the Caspian region with scattered records for the rest of the country

IUCN Red List:
Near Threatened (2016)
CITES:
Appendix II

Country Red List:
N/A
Iran environmental conservation laws & regulations:
Category II (Near Threatened and protected)

Photo F. Esfandiari

Distribution
Iran is likely the western boundary of the global distribution range of the Pallas's cat. The species is amongst the least studied felids in Iran and basic questions about its status and natural history have yet to be answered. In this study we gathered 84 new occurrence records of the Pallas's cat in Iran (C1 and C2; see Contemporary records), of which 72.6% (n = 61) were hard evidence (C1) and the remaining reliable sightings verified in this study (C2). Our data significantly increases the range of the species previously known from Iran (Fig. 4). North-eastern Iran is a hotspot of Pallas's cat occurrence in the country. More recent records also originated from the south-central provinces (Fig. 4). The Pallas's cat has not been reported in south-eastern Iran, though there are old anecdotal reports from neighbouring Pakistani Baluchistan (Pocock 1939, Roberts 1997). Therefore, our data indicate that as well as containing its western global range boundary, the Pallas's cat reaches also its southernmost known limit in Iran (30° N).

Historical records (up to 2000)
The manul presence in Iran was confirmed from an undated specimen reportedly obtained in "Meched" (Mashhad), Razavi Khorasan, by Sir P. R. Sykes (now in possession of the Natural History Museum of London; A. C. Kitchener, pers. comm.). Together with other specimens found from neighbouring countries, this specimen was a basis for Pocock (1939) to conclude that the Pallas's cat range in Iran is "northern Persian". No reports of the Pallas's cat were made over the three decades following this record (Lay 1967). Nonetheless, Misonne (1959) speculated about the species presence in north-west and north-east Iran based on the manul occurrence in Ararat, the Caucasus, and Turkmenistan in the vicinity of the Iranian border, respectively. Lay (1967) purchased a skin of unknown origin from a Tehran fur dealer (now in possession of Field Museum of Natural History, Chicago). Jamsheed (1976) and Firouz (1999) presented photos of different individuals both from Khosh Yeilagh Wildlife Refuge WR, Semnan Province. Etemad (1985) provided undated records from north-eastern Iran, including Sarakhs, in the vicinity of the Tajan River, the Iranian area bordering the Kopet Dagh Mountains, and adjacent to Nakhchivan and Aras River in northwest Iran (Fig. 4). There have also been unconfirmed reports of the felid from Mouteh WR in central Iran in the Wild Cat Action Plan (M. T. Moeinian, pers. comm. cited in Nowell & Jackson 1996).

Contemporary records: north-eastern Iran (Razavi, North, and South Khorasan Provinces)
North-eastern provinces hold the majority of recent confirmed records of the Pallas's cat presence in Iran, including several reserves: Salouk and Sarigol National Parks NP, Shaskouh Protected Area PA, as well as Heidari WR, Tandoureh NP, Gharchegheh PA, Helali PA, and southward to Dorouneh PA. Furthermore, the animal has been confirmed from vicinity of a number of urbanised areas, such as Chenaran, Torghabeh, Jajarm and Esfarayen. Camera trap deployed for leopard *Panthera pardus* in Salouk, Sarigol and Tandoureh NPs, North Khorasan Province, have photo-captured the Pallas's cat in multiple occasions (M. S. Farhadinia, unpubl. data; Fig. 1).
According to Rustamov & Sopyev (1994), the manul also exists in southern Turkmenistan, neighboring north-eastern Iran. Pocock (1939) also reported a specimen from east-

Fig. 2. Carcass of an erytristic morph of the Pallas's cat in Bafq, Yazd Province, in January 2008 (Photo Yazd DoE).

ern Ashkabad, close to the Iranian border in Turkmenistan. However, more recent surveys by Lukarevsky (2001) did not reveal new hard evidences from this region. The only verifiable record of the Pallas's cat we found from eastern Iran was a photo of an individual from Qaen County, South Khorasan Province (A. Khajavi, pers. comm.). In neighboring Afghanistan, the manul has been predominantly recorded from the eastern part of the country, far from the Iran-Afghan border zone (Habibi 2003).

Contemporary records: central and south-central Iran (Qom, Markazi, Semnan, Esfahan, Yazd, Fars, and Kerman Provinces)

Previous hard evidences from this region were restricted to Khosh Yeilagh WR in Semnan Province (Fig. 3; Ziaie 2008). Since the 2000s more records from the south-central provinces have become available. In Semnan Province, several individuals have recently been captured westwards along the Alborz Mountains, Khonar, Miami Mountain, vicinity of Shahmirzad, Seydoua NP and Damghan County (Fig. 4). In north-central Iran in mid-Alborz, the presence of the Pallas's cat has been confirmed in Khojir NP (Chalani et al. 2008) and Firouzkouh highlands, Tehran Province. Toward the west, we have also observed a stuffed specimen from Tafresh, Markazi Province, in a private collection. In addition to the mountainous northern territories, unexpected reports of the manul have been recently collected as far south as Semirom, Faridan and Karkas PA (Esfahan Province), Mehriz, Taft and Bafq (Yazd Province; Fig. 2), Rafsanjan, Sirjan, Shahr-e Babak and Bidou'eeyeh WR (Kerman Province) and Abadeh (Fars Province; Joolaee et al. 2014).

Contemporary records: Northwestern Iran or the Iranian Caucasus (Gilan, Ardabil, East and West Azarbayjan Provinces)

Northwestern Iran has been historically considered within the species range, and this has been confirmed by additional recent reports (Aghili et al. 2008). In north-western Iran, the Pallas's cat has been rarely recorded in the Caucasus, including south Armenia and south Azerbaijan (Ognev 1935, Heptner & Sludskii 1972, Alekperov 1989, Aghili et al. 2008). All of these sightings have been on the northern side of the Araz (or Aras) Valley that forms the border with Iran. Trapping of an adult female in Azar-Shahr, East Azarbayjan, in June 2008 finally confirmed the presence of the Pallas's cat in the Iranian Caucasus (Aghili et al. 2008).

Habitat

The Pallas's cat is most often sighted in stony alpine steppes and upland hilly areas, but is generally absent from lowland sandy desert basins. It seems that rocky and talus outcrops are predominantly preferred, and the geographical range of the Pallas's cat ends where the steppes meet forests (Heptner & Sludskii 1972). Semi desert landscapes of Central Asia are also inhabited by the species (Munkhtsog et al. 2004). Although upland habitats are preferred, deep snow is said to be a limiting factor (Sunquist & Sunquist 2002). Availability of suitable den sites is critical for the conservation of the species (Ross et al. 2012). Evidence suggests that den sites are selected in areas with higher proportions of rocky and ravine habitats in the surroundings (Ross et al. 2010a). Den sites are used for feeding, mating, raising kittens and predator avoidance (Ross et al. 2010a). Junipers (*Juniperus* spp.) are commonly seen in parts of the Pallas's cat highland habitats in Iran.

Despite this species has been reported from above 5,000 m in Tibetan Plateau, China (Fox & Dorji 2007) and Tso Lhamo Plateau, India (Chanchani 2008), the Iranian records are limited to altitudes of 2,500 m. The majority of Iranian records of Pallas's cat have originated from arid grassland steppes and rocky mountains. But a growing number of confirmed sightings suggest the species persistence on temperate regions as well, such as the southern slopes of Alborz Mountains. The presence of manul has also been confirmed in the mountains of Yazd Province, a primarily desert region (Fig. 2). Such a wide range of habitat features from arid mountains to temperate regions suggest the adaptability of Pallas's cats.

Ecology and behaviour

As a solitary cat, both sexes maintain large home ranges with intra- and inter-sexual overlap for males. In Mongolia, Ross et al. (2012) reported average male and female territories of 98.8 km^2 (21-207 km^2) and 23.1 km^2 (7.4-125.2 km^2), respectively. Activity period in the Pallas's cat is predominantly crepuscular (Ross 2009). However, Ross et al. (2010b) judged them to be mainly crepuscular or diurnal hunters, based on temporal pattern of their main prey activity. Breeding is highly seasonal and daylight dependent (Brown et al. 2002). After a gestation period of 66 to 75 days birth peaks in March-May, and two to, rarely, 8 kittens are born (Heptner & Sludskii 1972, Ross 2009). In Iran, two litters of three and four cubs (aging less than 2 weeks at the time of detection) have been recorded in May and early June 2014 from Maneh-va-Samalqan County, North Khorasan Province, and vicinity of Tandoureh NP (Fig. 5), Razavi Khorasan Province, both in north-eastern Iran.

Prey

The Pallas's cats feed mainly on small rodents and lagomorphs, in particular pikas of genus *Ochotona*. Moreover, small ground birds, hedgehogs, lizards and invertebrates are occasionally hunted. According to Heptner & Sludskii (1972), the manul's habitat is also typified by the presence of pikas and other small rodents, which constitute the bulk of its prey. The authors found remains of pikas in 89% of scats. In Mongolia, Ross et al. (2010b) recorded the manul feeding on a broad range of prey from insects to small mammals and birds. Nonetheless, diurnal pikas were highly

Fig. 3 A Pallas's cat in Khosh Yeilagh WR in September 2015 (Photo M. A. Adibi).

selected with the highest frequency of occurrence in diet in both summer (71.1%) and winter (47.6%).

There is no empirical data about the dietary composition of the Pallas's cat in Iran. Nevertheless, the majority of the known geographical range of this species (i.e., north to northeast) falls within the range of Afghan pika *O. rufescens* and great gerbil *Rhombomys opimus* (Harrington & Dareshuri 1976).

In captivity

The Pallas's cat has never been common within Iranian zoos and facilities. Purportedly from Sarakh (B. Ketabi, pers. comm.), northeastern-most Iran, two individuals were previously kept in Tehran zoo which are mentioned by Lay (1967) and Etemad (1985). In 2011, a juvenile manul originated from Kashan, south-central Iran, was in Iran DoE's Pardisan Eco-Park in Tehran for a short time prior to being kidnapped. Additonally, another manul of unknown origin and sex was in possession of Isar Zoo, Alborz Pro-vince until early 2016 (I. Memarian, pers. comm.). Presently, to our knowledge there are two manuls kept in captivity, one male from north-eastern Iran kept in Vakilabad Zoo, Razavi Khorasan, as well as another young manul kept by Esfahan DoE, originally from Hanna area, Semirom County. Recently, two juvenile individuals both kept by local offices of Iran DoE in north-eastern Iran (Fig. 5), died after a few months in captivity.

Main threats

The Pallas's cat is currently threatened throughout its range in Asia primarily due to habitat loss, hunting for the fur trade, and vermin control programs that result in depletion of its prey base and direct poisoning (Nowell & Jackson 1996, Ross et al. 2015). Unlike global concerns suggesting the fur trade as a major threat to the viability of manul populations (Brown & Munkhtsog 2000), the Iranian population seems not to suffer significantly from poachers, partially because of their rarity and elusive habits. However, human activities such as mining and traditional pastoralism, particularly during summer when alpine and sub-alpine rangelands are occupied by flocks of livestock, might have adverse impact on the Pallas's cat (Joolaee et al. 2014). We were able to gather 19 verifiable records of the Pallas's cat mortality from Iran. In 16 cases the cause of death was reported and the individuals were either killed by herding dogs (n = 7) or poached (n = 2). Furthermore, seven Pallas's cat died shortly after capturing by local people. There were also six cases of manul capturing by local people in recent years, reportedly released back into the wild. According to Munkhtsog et al. (2004), human disturbance may also affect Pallas's cat home range. A considerable proportion of the species range in Iran is inhabited by nomadic people who move seasonally, thus Pallas's cats may have to alter their activi-ty patterns and spatial behavior in avoidance of seasonally settled areas. However, recent evidences suggest that Pallas's cats are capable of inhabiting human-disturbed landscapes (Webb et al. 2014).

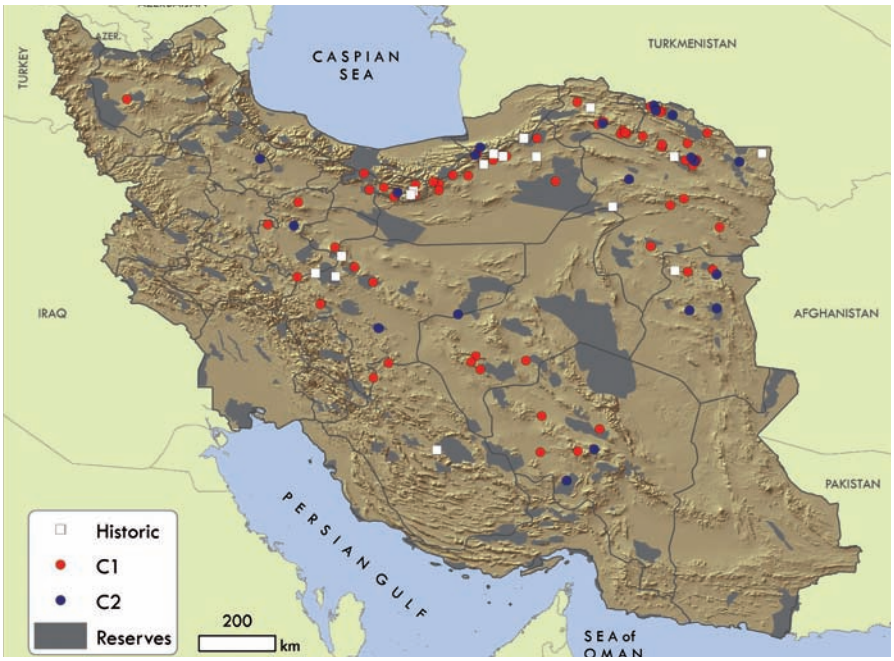

Fig. 4. Current distribution information for the Pallas's cat in Iran (1960-2015). Historical records (white square): confirmed presence records before 2000, including data from literature; C1 (red dot): hard evidences, such as photos, videos and dead specimens; C2 (blue dot): soft evidences, such as reliable field observations, either verified by us or via a trained person.

Protection measures

IUCN Red List of Threatened Species considers the manul's status as "Near Threatened" (Ross et al. 2015). In Asia, the Pallas's cat is also included in CITES Appendix II. Iran Hunting and Fishing Law 1967 (last revision 2015) classifies the Pallas's cat in Category II, defined as fully protected near threatened species. In addition, poaching will result in a fine of IRR 100,000,000 (1 USD ≈ 35,000 Iran Rials).

The recent increase in the number of captured Pallas's cats from different locations in Iran is of concern and necessitates awareness raising programs, particularly for herders who occasionally confuse the animal with small cheetah (e.g. in Bafq and Khabr NP, Yazd Province) or leopard cub (e.g. Tandoureh NP, Razavi Khorasan Province; Fig. 5). Recent conservation prioritization analysis based on evolutionary distinctiveness and globally endangered score has given the Pallas's cat a high priority for research and conservation actions in Iran, i.e. first ranking among Iran's lesser cats and one of top ten country's carnivore species (Farhadinia et al. 2016).

Fig. 5. A Pallas's cat cub perceived as a leopard cub and captured by a local herder in Tandoureh NP in April 2014 (Photo A. Moharrami).

The lack of scientific understanding of the Pallas's cat in Iran restricts our ability to conserve the species. The manul is difficult to detect in the wild and there are not many verifiable records from Iran. Identification and conservation of the Pallas's cat key habitats can play an important role in conservation planning for the species. Therefore, we recommend to conduct a large-scale habitat modeling exercise to better understand its potential distribution range not only within the Iranian boundary, but broader in western Asia. Although the distribution of the Pallas's cat in Iran appears much broader than it was first thought, the new range extension is not indicative of its better status in Iran. More research attentions are necessary by both national authorities and conservationists in order to assess the current conservation status of the Pallas's cat in the country.

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Supporting Online Material SOM Table T1 is available at www..catsg.org.

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