

## HABITAT ASSOCIATIONS OF PERSIAN WILD ASS (*EQUUS HEMIONUS ONAGER*) IN QATROUYEH NATIONAL PARK, IRAN

**HANIYEH NOWZARI**, *Department of Environment, Abadeh Branch, Islamic Azad University, Abadeh, Iran. Address: No.475, 90 alley, Ghasrodasht Avenue, Shiraz, Fars, Iran. P.O.Box: 71957-45343; Phone: 0098-917/312-0642; Email: hnowzari@princeton.edu*

**MAHMOUDREZA HEMAMI**, *Department of Natural Resources, Isfahan University of Technology, Isfahan, Iran*

**MAHMOUD KARAMI**, *Department of Environment and Energy, Science and Research Branch, Islamic Azad University, Tehran, Iran*

**MIR MASOUD KHEIRKHAH ZARKESH**, *Department of Environment and Energy, Science and Research Branch, Islamic Azad University, Tehran, Iran*

**BORHAN RIAZI**, *Department of Environment and Energy, Science and Research Branch, Islamic Azad University, Tehran, Iran*

**DANIEL I. RUBENSTEIN**, *Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ 08544, USA*

**ABSTRACT:** Persian onager (*Equus hemionus onager*) is an endangered species whose populations in semi-arid ecosystems of Iran have continued to decline during the last few decades. The basic ecology of onagers in Iran is poorly understood and there is scarcity of knowledge to base management activities for conservation of the species. Between autumn 2009 and summer 2010 the location of onager herds were recorded using GPS in Qatrouyeh National Park (QNP). Habitat variables, including NDVI, slope, elevation, aspect, distance to nearest road, and distance to nearest water resource, were extracted for GPS locations of onagers. Principal Component Analysis was used to determine the most important factors influencing habitat use by onagers. In the cold season (Dec—Mar), use of habitat was positively related to distance to nearest road and distance to nearest water resource, and negatively associated with NDVI. In the hot season (Aug—Nov), the pattern of habitat use was associated positively with NDVI and slope, and negatively with distance to nearest water resource. Onager habitat use was related positively to slope and distance to near-

est road, and negatively to distance to nearest water resource during the moderate season (Apr—Jul). Our results showed onagers were not near water resources during cold season when water stress was least, whereas they were near water resources during moderate and hot seasons because of increased water stress. Also onagers were far from roads likely to avoid from human presence. Onagers tended to use higher slopes during moderate and hot seasons to avoid high temperatures in the plains. During the hot season when herbaceous forage was scarce in QNP, onagers used areas with high NDVI and higher cover of green bush and shrub layer. They use areas with low NDVI during cold season when annual grasses were more common after rainfall in these areas.

**KEY WORDS:** GIS, habitat modeling, NDVI, Persian onager, seasonal habitat use.

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Horses, zebras and asses, members of the family Equidae, once flourished and inhabited a range of environments in the Americas, Europe, Africa, and Asia. Today, 5 out of 7 extant Equids are now listed as “Threatened” by the International Union for Conservation of Nature (IUCN), including *Equus ferus* and *E. africanus* as critically endangered, *E. hemionus* and *E. grevyi* as endangered and *E. zebra* as vulnerable (IUCN 2008). Once distributed from China to Turkey and India to Kazakhstan, the Asiatic wild ass or onager (*Equus hemionus*) now exists only in parts of China, India, Mongolia, Kazakhstan, Turkmenistan, and Iran (Moehlman 2002). The Persian onager (*E. h. onager*), 1 of the 5 subspecies of *Equus hemionus*, has been declining in numbers over recent decades and is restricted to 2 isolated populations in 2 semi-arid ecosystems of Iran. Consequently, this taxon was categorized as critically endangered (Tatin et al. 2003, IUCN 2008). Also, other subspecies are listed as threatened by the IUCN except for *Equus hemionus hemippus* which is already extinct.

One of the central tenets of behavioral ecology is that features of the environment shape animal behavior (Krebs and Davies 1997). Choice of habitat affects resource use, which in turn affects competition, grouping behavior, mating activities and ultimately reproductive success and fitness (Lawes and Nanni 1993). Understanding the forces that shape habitat use (Henley et al. 2007, Nowzari et al. 2007) is essential for understanding how behavior influences population and ecological dynamics as well as resource availability (Sibly and Smith 1985). By deciphering the rules determining

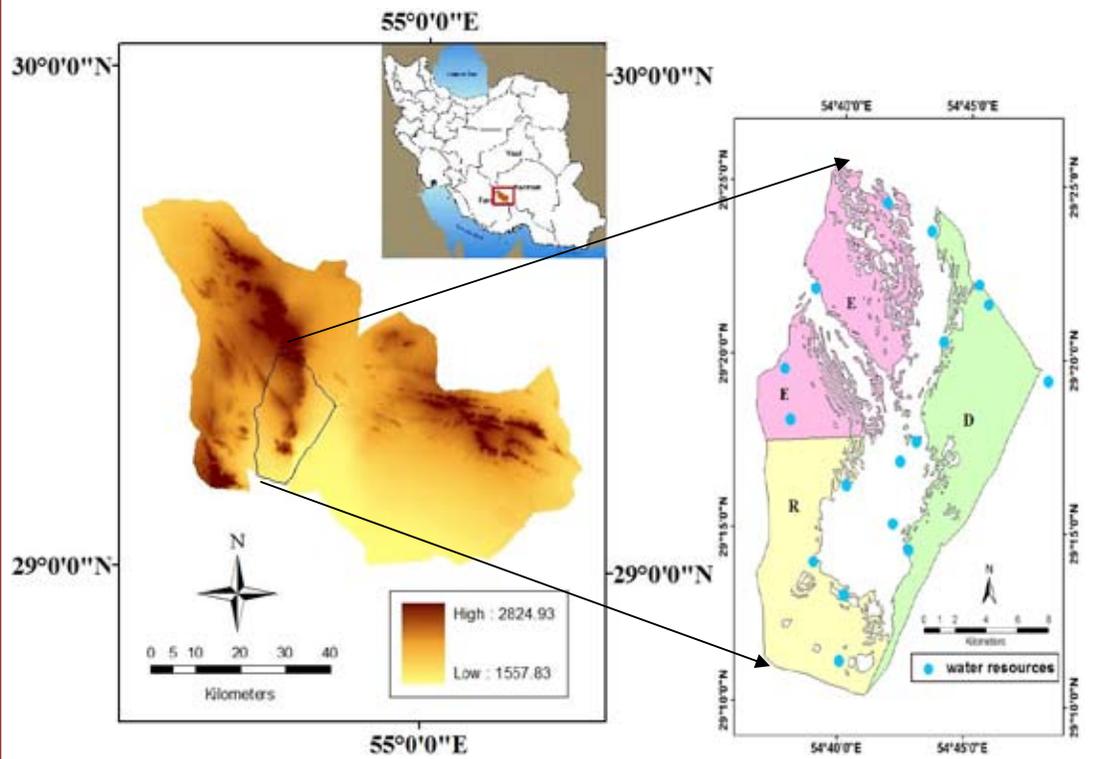


Fig 1A

Fig 1E

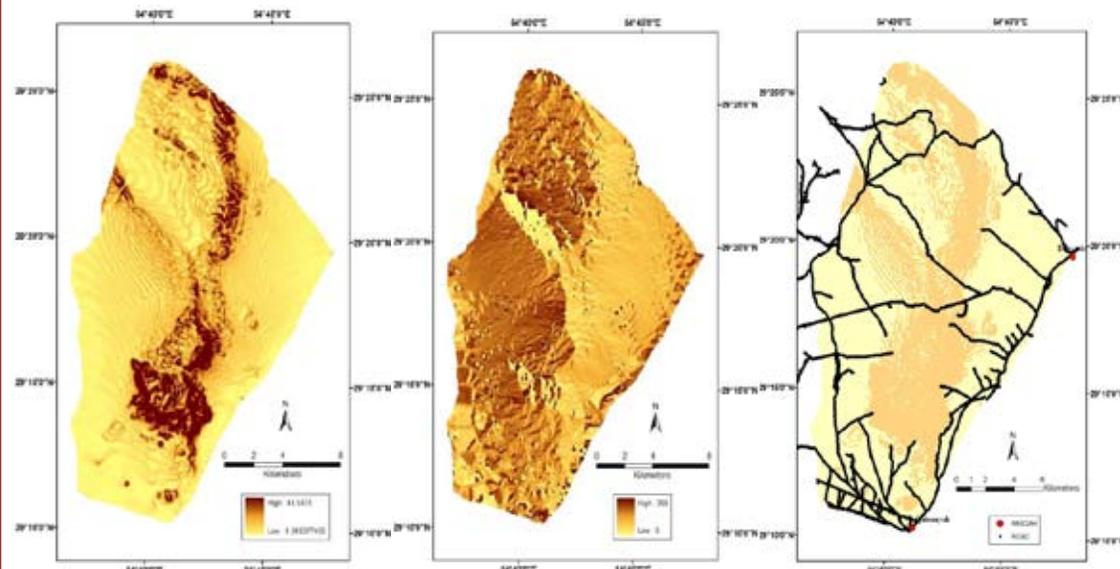


Fig 1B

Fig 1C

Fig 1D

Figure 1. (A) Digital elevation model map of Bahramegoor Protected Area and its location in Iran; Black lines show the boundaries of Qatrouyeh National Park (QNP). (B) Slope map of QNP. (C) Aspect map of QNP. (D) Roads map of QNP. (E) Water resources map of QNP.

Table 1. Habitat use model of Persian onager, based on a principal components analysis.

Season	NDVI	Slope	Distance to nearest roads	Distance to nearest water resources	Cumulative percent
Cold	-0.60 <sup>a</sup>		0.81	0.86	86.92
Moderate		0.61	0.76	-0.80	82.58
Hot	0.70	0.65		-0.75	87.20

<sup>a</sup>Eigen values

how environmental features shape behavior, conservation biologists should be able to manipulate this link by changing human behavior to improve a species' prospects of survival, enhance ecosystem function, and improve human livelihoods in environmentally sustainable ways (Rubenstein 2010). Overall, behavioral ecology has much to offer for solving conservation problems (Caro 1998).

Currently, Qatrouyeh National Park (QNP) and Touran National Park (TNP) are the last strongholds for Persian onager in Iran (Ziaee 2008). However, except for a few studies (Groves 1974, Harrington 1977) information about the ecology of populations in these protected areas is limited. Understanding temporal and spatial patterns of habitat use provides a critical foundation for management (Moore 2008), especially in equids (Moehlman 2002). There is a lack of information about population size, habitat relationships and population structure of the Persian onager (Duncan 1992, Moehlman 2002). The aim of this study was to model the habitat use of Persian onagers to be a base for further studies which can assist in the species conservation and management (Suring and Vohs 1979, Hemami et al. 2004, Sundaresan et al. 2007, Kaczensky et al. 2008).

## STUDY AREA

Bahramgeoor Protected area (BPA) was established in 1972 and is 408,000 ha in size. It is located 55 km away from Neyriz city and is near Qatrouyeh town in Fars province (Darvishsefat 2006). Qatrouyeh National Park was deemed by the Department of Environment (DOE) as the core zone of BPA in 2007, which is located at 29° 10' to 29° 26' N and 54° 36' to 54° 48' E (Fig. 1). Qatrouyeh National Park has an area of 32,576 ha, and a range in elevation of 1,680–2,787 m above sea level. Its terrain consists of mountains and

desert-like plains. Its average annual rainfall ranged from 150 to 250 mm per year and thus is considered a semi-arid ecosystem. Maximum temperature was 44°C and minimum temperature was -1°C during the hottest and the coldest months. Qatrouyeh National Park includes part of Zagros Mountains and consists of 3 main landscapes: the Koohsorkh-e-bozorg Mountains, the Rigjamshid, Einaljalal and Dehvazir plains, and the remaining area containing many hills and valleys. Water comes from natural springs and human-made wells and troughs. Three vegetation communities predominated: *Artemisia—Zygophyllum*, *Artemisia—Amygdalus*, and Rock (Qatrouyeh NP—Bahramgeoor PA comprehensive management plan 2010). Apart from Persian onager, large herbivores such as wild sheep (*Ovis orientalis*), wild goat (*Capra aegagrus*), and Jebeer gazelle (*Gazella bennettii*), and carnivores such as grey wolf (*Canis lupus*), golden jackal (*Canis aureus*), red fox (*Vulpes vulpes*), striped hyaena (*Hyaena hyaena*), caracal (*Felis caracal*), and leopard (*Panthera pardus*), occur in the area (Darvishsefat 2006). The number of onagers has been estimated to be 270 individuals (Hemami and Momeni in press).

## METHODS

### Field Data Collection

We recorded the latitude and longitude of all of Persian onager sightings in QNP during 4 seasons (autumn 2009, winter, spring and summer 2010). We drove fixed loops during day from sunrise to sunset 3 days per week—1 day for each plain (Rigjamshid, Einaljalal, and Dehvazir plains)—during nonconsecutive 2-week periods every month. This resulted in 6 observations every month, 18 per season and 60 per year, excluding February and June. The research team consisted of 4 observers, each a wildlife expert equipped with 8×30 binoculars, who traveled along all available routes

through QNP, stopping wherever a herd was spotted. To count the onagers in each herd, 1 team member approached the herd, guided by 2-way radio from the other team members who observed from a distance. When within 10 m of the herd, the GPS location was recorded along with herd size, habitat type, time and date, recently left traces of the herd like feces, urine, and spoor tracks, and water resources near the herd.

### NDVI

Normalized Difference Vegetation Index (NDVI) values were used to characterize vegetation. Typically NDVI indicates the greenness of vegetation, or vegetation quality. We examined the NDVI values of the GPS locations of onagers to determine the features of the vegetation in areas used by onagers across seasons. To determine selectivity of habitat use the values associated with observed onager locations were compared to values associated with 200 random points using ArcGIS 9.3 (Esri, Redlands, CA) and Hawth's Tools (<http://www.spatial ecology.com/htools>, accessed 31 October 2012).

### Habitat Use Analysis and Model

Six habitat variables, including NDVI, slope, elevation, aspect, distance to nearest road, and distance to nearest water resource, were extracted for GPS locations of onagers (Figure 1) with ArcGIS and Hawth's Tools. Principal Component Analysis (PCA) was used to find the most important factors affecting habitat use by onagers. Months were classified into 3 seasons based on environmental harshness: hot season (Aug—Nov), moderate season (Apr—Jul), and cold season (Dec—Mar). Initially, we used elevation and aspect, but those variables overwhelmed the relationships with the remaining variables, which we believed were more important to describe the habitat from the onager's perspective.

### RESULTS

A total of 682 herd locations were recorded throughout the 1-year period, and the results from the PCA of those locations are in Table 1. Our findings show that in the cold season, use of habitat was positively related to distances to nearest road and to nearest water resource, and negatively associated with NDVI. In other words, onagers used areas that were farther from water resources and roads and had low NDVI. In the moderate season, onager habitat use was positively related to slope and to distance to nearest road, and negatively associated with distance to nearest water resource. That is, onagers used areas at higher slopes, farther from roads, and nearer to water resources. In the hot season, habitat use was positively associated

with NDVI and slope and negatively associated with distance to nearest water source. In other words, onagers used higher slopes, and areas that had high NDVI and were nearer to water resources.

### DISCUSSION

This was the first study in Iran to characterize patterns of seasonal habitat use of the Persian onager over consecutive years. Spatial and temporal variability in vegetation and habitat use is common for many free-ranging herbivores across the world (Palmer et al. 2003) and our findings show that the Persian onager is no exception.

Our results indicate that during cold season onagers were not near water resources. In cold weather the loss of water through evaporation decreases and hence the need for visiting watering points decreases too. Also, onagers used areas with lower NDVI, likely because they use areas with newly grown annual grasses in this season which, compared to the remaining areas with denser bush and shrub cover have lower NDVI values. Moreover, onagers were far from roads likely to avoid from human presence.

Our results also show that during moderate season onagers tended to use higher slopes, likely to avoid the high temperature in the plains than hills, valleys, and mountains. As with the cold season, onagers were far from roads likely to avoid from human presence. In contrast, onagers were near water resources, likely because they needed more water during the warmer and more arid moderate season.

Our results also reveal that during hot season onagers were seen in higher slopes. Lack of rainfall and reduced abundance of annual grasses in QNP likely caused onagers to use areas with higher cover of green bush and shrub layer with a higher NDVI signature. Owing to these reasons as well as needing much more water, they were also found near water resources in this water-limited season.

The results of our habitat use model accord with the results of studies performed on Persian onager's population in TNP: onagers tend to live around hills, close to springs and water resources, and avoid roads (Madani 2008, Bagheri 2011). In addition, our findings support the results of (Momeni 2009), that there is a negative relationship between Persian onagers' pellet groups in QNP and distance to water resources, which in turn indicates onagers' high dependence on water particularly in the hot season.

### MANAGEMENT IMPLICATIONS

The results of this study can contribute to onager management and conservation in arid ecosystems of Iran. Reintroduction programs of onagers from QNP to oth-

er protected areas are under study by the DOE. Our findings indicate that habitat use is mostly affected by the availability of quality food and water but that the impacts of these key resources vary by physical factor of environment and human presence. In general, hill-valley habitats are used by onagers in QNP. Therefore, future translocations of onagers should include these habitats. The presence of onagers near water and in areas with high-quality vegetation within QNP shows that both adequate water resources and high-quality food must be abundant in any future locations. Thus, choosing future sites that maximize onager survival must take precedence if new populations of onagers are to be sustained.

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