

On the distribution of *Felis margarita* and *Felis lybica* in SW Morocco

Sobre la distribución de *Felis margarita* y *Felis lybica* en el sudoeste de Marruecos

Arlo Hinckley^{1*}, Eduardo José Rodríguez-Rodríguez², H. Christoph Liedtke³, M^a Isabel García-Tardío⁴, M^a Victoria Flores-Stols⁵ & Luis García-Cardenete⁶

1. Conservation and Evolutionary Genetics Group, Estación Biológica de Doñana, Avda Américo Vespucio 26, 41092 Sevilla, Spain
2. Grupo Ecología, Evolución y Conservación de Vertebrados, Universidad de Sevilla, C/ Francisco Collantes de Terán 2, 2º 8, 41010 Sevilla, Spain
3. Ecology, Evolution and Development Group, Estación Biológica de Doñana, Avda Américo Vespucio 26, 41092 Sevilla, Spain
4. Plan de Recuperación del Lince Ibérico (*Lynx pardinus*), Agencia de Medio Ambiente y Agua, Consejería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible, Junta de Andalucía, Avda. de Andalucía 104, Esc 3 1º, 23006 Jaén, Spain
5. C/ Calvario 8, 13343 Villamanrique, Ciudad Real, Spain
6. C/ Carrera de San Agustín 24, 2º A, 18300 Loja, Granada, Spain

* Corresponding author: arlohinckley90@gmail.com

The West Sahara-Sahel of Africa, can be considered one of the most heterogeneous and diverse arid areas in the world, covering up to twelve ecoregions (Olson *et al.* 2001). However, due to its remoteness and political instability/conflicts during the last decades, biodiversity distribution knowledge in West Sahara-Sahel (WSS) is scarce in comparison with other regions (Brito *et al.* 2014, Durant *et al.* 2014). Despite 105 mammals having been recorded in West Sahara-Sahel (IUCN 2015), detailed knowledge on their distribution and ecology is known for just a handful of species (Vale *et al.* 2016). Within mammals, felids are among the most challenging to study and least known, due to their secretive behaviour and generally highly threatened status in the area (Belbachir *et al.* 2015). In such a scenario, it is important to improve the understanding of their distribution in order to develop effective conservation and management strategies (Dorcas & Wilson 2009).

The sandcat (*Felis margarita* Loche, 1858) is the only cat to occur exclusively in deserts. Throughout its range it inhabits vegetated sand desert, sand dune plains, sand and gravel desert, but also rocky desert habitats in some parts of its range, questioning its need for sandy areas (Schauenberg 1974, Hemmer *et al.* 1976, Cole & Wilson 2015). Soil stability seems to be important for prey availability (small-mammal prey often live clustered around vegetation

and generally do not venture onto bare sand) and for stable den establishment. In spite of this, this species is more common in sandy deserts and less common where the substrate is compacted or composed of clay (Cole & Wilson 2015). The African wildcat (*Felis lybica* Forster, 1780) in comparison is a generalist species with a broad habitat tolerance. It is found from deserts, scrubland, and savannahs to grasslands and mountain forests. Its distribution in WSS is mainly restricted to coastal and mountain areas (Vale *et al.* 2016).

Based on a combination of literature published records, scientific collection specimens, biodiversity citizen science resources (Observation.org) and data from recent field campaigns (Appendices 1 and 2), we provide an updated distribution map of these species in the WSS, particularly, in the lower Draa region of SW Morocco (Fig. 1). The field campaign records are opportunistic observations of animals found in water cisterns over a survey period from 2012-2018. These cisterns are subterranean, usually concrete structures with small, surface-level entrances where rainwater is drained into. Although some are reliably filled with water, many are dry for long periods of time. Animals falling in are at risk of either being trapped or drowning.

These new records highlight a broader extent of occurrence of *Felis margarita* than previously thought. The IUCN Red List distribution

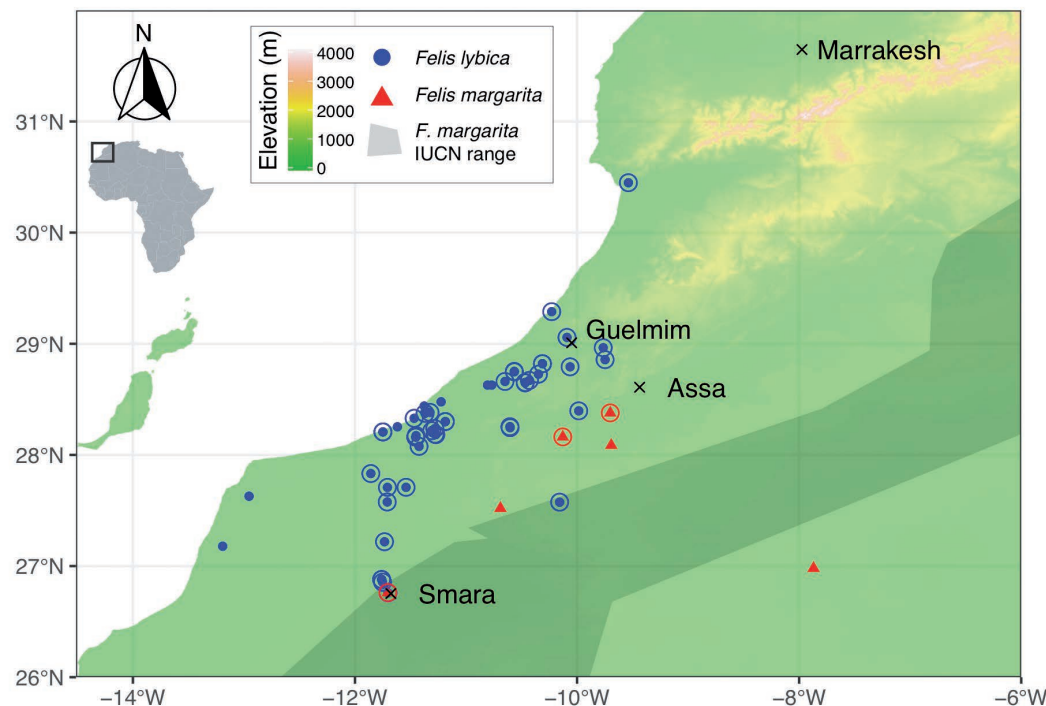


Figure 1. Topological map of the Lower Draa region in West Sahara-Sahel showing records of *Felis margarita* (red triangles) and *F. lybica* (blue points). New records published here are annotated with a circle around the dot. The IUCN range map of *F. margarita* is also shown as a translucent polygon. The range of *F. lybica* is not shown as it extends across the entire map.

map (IUCN 2020) for this species seems to underestimate its distribution especially towards the north-western part of its range in the Lower Draa, highlighting the necessity of additional field studies in this area. Another observation to be remarked is that *F. lybica* and *F. margarita* can be found in syntopy in Morocco, as confirmed by our records from Smara (Fig. 1). Finally, the negative effect that water cisterns might pose to these two species should be highlighted. Two out of three *F. margarita* and 27 out of 43 *F. lybica* individuals were found dead in these structures either from dehydration or starvation if cisterns are dry, or from drowning if cisterns are filled. This suggests that some of these might act as death traps, as has been shown for many small vertebrates of this region such as reptiles (García-Cardenete *et al.* 2014) and small mammals (authors unpublished data). In fact, such small vertebrates might act as baits, attracting the feline predators towards these traps. The type of construction and their conditions greatly influences their lethality however and partially collapsed or sand filled cisterns may also serve as refuges. For example, a record of a female *Felis lybica* and three cubs suggests that water cisterns can also serve as

breeding dens for this species. It is important to stress that records we report here are opportunistic and prone to bias, but they highlight the need for more detailed and quantitative field studies to properly assess the fine-scale distribution of these elusive species and the impact of water cisterns.

Acknowledgements

C. Urdiales provided assistance at EBD-CSIC scientific collection.

References

- Belbachir F., Pettorelli N., Wachter T., Belbachir-Bazi A. & Durant S.M. 2015. Monitoring rarity: the critically endangered Saharan cheetah as a flagship species for a threatened ecosystem. *PLoS One*, 10 (1): e0115136. DOI: [10.1371/journal.pone.0115136](https://doi.org/10.1371/journal.pone.0115136)
- Brito J.C., Godinho R., Martínez-Freiría F., Pleguezuelos J.M., Rebelo H., Santos X., Vale C.G., *et al.* 2014. Unravelling biodiversity, evolution and threats to conservation in the Sahara-Sahel. *Biological Reviews*, 89: 215-231. DOI: [10.1111/brv.12049](https://doi.org/10.1111/brv.12049)
- Cabrera A. 1932. *Los Mamíferos de Marruecos*. Trabajos del Museo Nacional de Ciencias Naturales. Serie Zoológica número 57, Madrid, 361 pp.

- Cole F.R. & Wilson D.E. 2015. *Felis margarita* (Carnivora: Felidae). *Mammalian Species*, 47 (924): 63-77. DOI: [10.1093/mspecies/sev007](https://doi.org/10.1093/mspecies/sev007)
- Dorcas M.E. & Wilson J.D. 2001. Innovative methods for studies of snake ecology and conservation. Pp. 5-37. In: Mullin S.J. & Seigel R.A (eds). *Snakes: Ecology and Conservation*, Cornell University Press, Ithaca NY.
- Durant S.M., Wachter T., Bashir S., Woodroffe R., de Ornellas P., Ransom C., Newby J.E. *et al.* 2014. Fiddling in biodiversity hotspots while deserts burn? Collapse of the Sahara's megafauna. *Diversity and Distributions*, 20: 114-122. DOI: [10.1111/ddi.12157](https://doi.org/10.1111/ddi.12157)
- García-Cardenete L., Pleguezuelos J.M., Brito J.C., Jiménez-Cazalla F., Pérez-García M.T. & Santos X. 2014. Water cisterns as death traps for amphibians and reptiles in arid environments. *Environmental Conservation*, 41 (4): 341-349. DOI: [10.1017/S037689291400006X](https://doi.org/10.1017/S037689291400006X)
- Hemmer H., Grubb P. & Groves C.P. 1976. Notes on the Sand Cat, *Felis margarita* Loche, 1858. *Zeitschrift für Sugetierkunde*, 41: 286-303.
- IUCN. 2020. The IUCN Red List of Threatened Species. Version 2020-2. <https://www.iucnredlist.org>. Accessed on 10th November 2020.
- Kowalski K. & Rzebik-Kowalska B. 1991. *Mammals of Algeria*. Polish Academy of Sciences, Krakow, 370 pp.
- Olson D.M., Dinerstein E., Wikramanayake E.D., Burgess N.D., Powell G.V.N., Underwood E.C., D'Amico J.A. *et al.* 2001. Terrestrial Ecoregions of the world: a new map of life on Earth. *BioScience*, 51: 933-938.
- Schauenberg P. 1974. Données nouvelles sur le Chat des sables "*Felis margarita*" Loche, 1858. *Revue Suisse de Zoologie*, 81: 949-969.
- Valderrama J.M., Gil-Sánchez J.M., Díaz-Portero M.A., Rodríguez-Siles J., Herrera-Sánchez F.J., Valenzuela G., Arredondo A. *et al.* 2015. *Expediciones zoológicas al Sahara Atlántico*. Harmusch, Asociación del Estudio y Conservación de Fauna. Ediciones Rodeno. Valencia. 206 pp.
- Vale C.G., Campos J.C., Silva T.L., Gonçalves D.V., Sow A.S., Martínez-Freiría F., Boratyński, Z. & Brito J.C. 2016. Biogeography and conservation of mammals from the West Sahara-Sahel: an application of ecological niche-based models and GIS. *Hystrix*, 27 (1): 1-10. DOI: [10.4404/hystrix-27.1-11659](https://doi.org/10.4404/hystrix-27.1-11659)

Submitted: 26 November 2019

Accepted: 26 November 2020

Associate editor was Javier Calzada

Appendix 1. Distribution data of *Felis lybica* and associated information.

Latitude (N) Longitude (W)	Locality	Origin of data	Date	State
29,1N -10,1W	Imi N'Fast	This study	6/4/12	Run-over
28,8N -10,3W	Zraouilla	This study	24/9/12	Alive, in water cistern
28,2N -11,7W	N1, Khnifiss - Chbika	This study	28/3/18	Unavailable
27,6N -10,1W	Oued Afra	This study	24/5/17	Female and three cubs, in water cistern
26,8N -11,7W	Smara	This study	11/4/17	Run-over
28N -11,4W	Ben Khlil- Abteh road	This study	Unavailable	Alive
27,7N -11,7W	Laâyoune - Sakia El Hamra	This study	Unavailable	Alive
28,2N -11,4W	Ben Khlil - Abteh road	This study	Unavailable	Alive
26,9N -11,8W	Sidi Ahmed Laroussi	This study	Unavailable	Alive
28,3N -11,2W	Tan Tan - Abteh road	This study	Unavailable	Alive
28,7N -10,6W	Rass Oumlil	This study	Unavailable	Alive
28,2N -10,6W	Track Tiglit - Msied	This study	Unavailable	Alive
26,8N -11,7W	North of Smara	This study	Unavailable	Alive
30,4N -9,5W	Agadir	This study Col. EBD30464	6/2/17	Dead in water-cistern
27,7N -11,5W	Oued Orad 24km SSW of Abteh	This study	13/9/15	Dead in water-cistern
28,1N -11,4W	Oued Chbika	This study	22/10/15	Alive
26,9N -11,7W	Tan Tan - Smara	This study	22/9/16	Run-over
28,3N -11,1W	R101, 30 km W Tan Tan	This study	15/11/16	Run-over
28,9N -9,8W	Fask - Tahjijt	This study	28/3/18	Alive
29,3N -10,2W	Ifni-Foum Assaka	This study	24/9/16	Dead in water-cistern
28,7N -10,4W	Douar El Ain - Aouinet Ighoumane	This study	16/10/16	Dead in water-cistern
28,7N -10,6W	Ras Azayyar	This study	4/11/16	Dead in water-cistern
28,7N -10,6W	Ras Azayyar	This study	4/11/16	Dead in water-cistern
28,8N -10,3W	N1, Guelmim-Tan Tan	This study	5/11/16	Dead in water-cistern
28,3N -11,5W	N1, Tan Tan-Tarfaya	This study	11/11/16	Dead in water-cistern
28,1N -11,4W	Chbika	This study	11/11/16	Dead in water-cistern
28,4N -10,0W	Oued Draa, Taskala	This study	14/4/17	Dead in water-cistern
28,4N -11,4W	Sebha El Harcha	This study	16/10/17	Dead in water-cistern
28,4N -11,3W	Sebha El Harcha	This study	16/10/17	Dead in water-cistern
28,2N -11,3W	Sebha El Harcha	This study	17/10/17	Dead in water-cistern
27,2N -11,7W	R101, Abteh-Smara	This study	21/10/17	Dead in water-cistern
27,6N -11,7W	Oued Al Dari	This study	21/10/17	Dead in water-cistern
27,8N -11,8W	R101 Sidi Akhfenir	This study	27/10/17	Dead in water-cistern

Continuation Appendix 1. Distribution data of *Felis lybica* and associated information.

28,2N -11,3W	Sebha El Harcha	This study	24/3/18	Dead in water-cistern
28,2N -11,3W	Sebha El Harcha	This study	24/3/18	Dead in water-cistern
28,7N -10,3W	Douar El Ain-Aouinet Ighoumane	This study	26/3/18	Dead in water-cistern
28,2N -10,6W	Djebel Rich	This study	2/5/18	Dead in water-cistern
28,8N -9,7W	N12 Assa-Guelmim	This study	8/6/18	Dead in water-cistern
28,2N -11,7W	N1 Khnifiss-Chbika	This study	23/10/18	Dead in water-cistern
28,8N -10,1W	Djebel Taïssa	This study	20/4/19	Dead in water-cistern
28,6N -10,5W	Douar El Ain - Aouinet Ighoumane	This study	22/4/19	Dead in water-cistern
28,6N -10,5W	Douar El Ain - Aouinet Ighoumane	This study	22/4/19	Dead in water-cistern
28,2N -11,3W	Sebha El Harcha	This study	25/4/19	Dead in water-cistern
28,2N -11,6W	N1, Southwest Ben Khilil	observations.org	Unavailable	Run-over
27,6N -12,9W	South of Tah	observations.org	Unavailable	Run-over
28,5N -11,2W	El Oautia-Tan Tan	inaturalist.org	30/5/17	Alive in water cistern
27,2N -13,2W	Laâyoune	Cabrera (1932)	Unavailable	Unavailable
28.6N -10.8W	Rass Oumlil	Vale <i>et al.</i> (2016)	29/12/06	Run-over
28.4N -11.4W	El Outia	Vale <i>et al.</i> (2016)	29/12/06	Run-over
28.6N -10.8W	Rass Oumlil	Vale <i>et al.</i> (2016)	23/10/10	Run-over
17.1N -12.6W	Kifa	Vale <i>et al.</i> (2016)	16/11/10	Alive
17.2N -13.8W	Aleg	Vale <i>et al.</i> (2016)	17/11/10	Run-over

Appendix 2. Distribution data of *Felis margarita* and associated information.

Latitude (N) Longitude (W)	Locality	Origin of data	Date	State
28,2N -10,1W	Assa-Msied. Maader Asfer. Oued Tizert	This study	Unavailable	Dead in water-cistern
26,8N -11,7W	North of Smara	This study	Unavailable	Run-over
28,4N -9,7W	Oued Draa, SW of Assa	This study	Unavailable	Dead in water-cistern
27N -7,9W	South of Tindouf	Kowalski & Rzebik-Kowalska (1991)	Unavailable	Unavailable
27,5N -10,7W	Djbel Ouarkiz, South of Msied	Valderrama <i>et al.</i> (2015) (aprox. coordinates)	Unavailable	Unavailable
28,1N -9,7W	West of Zag	Valderrama <i>et al.</i> (2015) (aprox. coordinates)	Unavailable	Unavailable