Status of *Vipera latastei* Boscá, 1878 in the province of Seville and its ecological determinants

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Resumen: La víbora hocicuda (*Vipera latastei*) es una especie rara y de difícil detección en la provincia de Sevilla. En este estudio se recopilaron 22 registros confirmados (2012–2025) y se desarrolló un modelo de favorabilidad ambiental a escala UTM 10×10 km para estimar su distribución potencial. El modelo, basado en regresión logística penalizada y validación cruzada, mostró un buen rendimiento (AUC = 0,85) e identificó el matorral denso, la humedad topográfica, la cobertura forestal y la irradiancia estival (efecto negativo) como los principales factores que condicionan su presencia. Las áreas más favorables se concentran en Sierra Morena, con presencia limitada en la Sierra Sur y valores prácticamente nulos en el valle del Guadalquivir. Los resultados permiten delimitar áreas prioritarias para la conservación y resaltan la necesidad de implementar programas de seguimiento estandarizados.

Vipera latastei is distributed across much of the southern and central Iberian Peninsula, with a few confirmed populations in the south and west of Ourense and an irregular presence in La Rioja, Navarra, Aragón, and some isolated sites in Catalonia (Pleguezuelos & Santos, 2002). The species occurs from sea level up to nearly 3,000 m and shows small overlap with other vipers, with distribution limits shaped by ecological factors and competition (Martínez-Freiría *et al.*, 2008). It is absent from the more northern and humid areas of Spain (Cantabrian Mountains and the Pyrenees, which correspond to the Atlantic and Alpine bioregions, respectively). Although it is more frequently found in mountainous and sparsely populated areas, it is not strictly montane, as it avoids highly humanised regions, as evidenced by its presence in lightly populated coastal areas such as Doñana.

In the province of Seville, the species is mainly distributed in the north, in the Sierra Morena. However, it is also found in the Sierra Sur, within the Subbética mountain ranges, where it occurs at low densities and with reduced detectability (Rodríguez-Rodríguez *et al.*, 2018). Studies based on mitochondrial DNA suggest the presence of two subspecies in the province: *V. latastei gaditana* in Sierra Morena and *V. latastei arundana* in Sierra Sur (Martínez-Freiría *et al.*, 2021); however, these findings need to be confirmed using nuclear markers, as mitochondrial data reflect only the maternal lineage and may not fully capture overall population structure or ongoing gene flow.

In this work, we compiled records of individuals observed and verified through photographs since 2012, located within the province of Seville or in 10×10 km UTM grid cells partially overlapping the province. All records have concrete coordinates and have been verified by the authors. These included both our own observations and citizen science records obtained from Observation.org (2025). All data were used to build an environmental favorability model. As non-detections, we included survey locations visited during our viper surveys where other snake species were detected but *Vipera latastei* was not recorded (each site was visited approximately 5 times). Environmental predictors were generated at a 10×10 km UTM grid scale and included bioclimatic, topographic, habitat, and anthropogenic variables (such as population density and road networks) (SEO/BirdLife, 2022), as well as the length of river segments within each cell. The complete list of 147 variables is included in Annex 1*.

Next, we implemented a structured environmental modelling workflow in R (R Core Team, 2025) to characterise the relationship between the species presence probability and the surrounding ecological variables. After univariate ranking of predictors by AUC, an iterative collinearity control was applied using variance inflation factors (VIFs), with variables with the highest VIFs removed successively until all remaining predictors met the threshold (VIF < 10), ensuring low interdependence among predictors. The main modelling stage consisted of an iterative ridge-penalised logistic regression (package glmnet, Friedman *et al.*, 2010) fitted using 5-fold cross-validation. The model was fitted iteratively, with less stable predictors removed or rotated until internal stability criteria were met, based on the distribution of predicted favourabilities. Specifically, stability was defined by a minimum standard deviation of predicted favourability (SD ≥ 0.05) and a mean predicted favourability within the range 0.05–0.95, ensuring an informative and non-degenerate response. If these conditions were not satisfied, predictors were progressively removed in order of decreasing AUC until stability was achieved. Finally, favourability is calculated by correcting for prevalence (Real *et al.*, 2006), and the outputs (including the model, predictions, and a comprehensive summary of retained variables, final method, and performance metrics) are stored.

Additionally, photographs of individuals observed in the province were collected to document and describe the phenotypes observed. These images enabled analysis of morphological traits (length and weight, although they were not used in this study), colouration patterns (skin colour and dorsal pattern), and intraspecific variability, contributing to a better understanding of the species' phenotypic diversity in the region.

As a result, a total of 22 records of *Vipera latastei* were compiled (four with a brown morph and an angular zig-zag pattern, and 18 with a grey morph and a wavy zig-zag pattern; see Figure 1). We also recorded 82 negative locations. The variables selected by the model for providing the best fit, in order of importance, were dense shrub cover, topographic wetness index, total forest cover, forest cover density, and mean global summer irradiance. Validation metrics were: AUC = 0.85; Sensitivity = 1; Specificity = 0.69; TSS = 0.69.

See Annex 1 in: <url correspondiente>

Table 1: Variables included in the model. (Method: ridge_iter; n = 104 observations; 147 initial variables; no collinearity filtering; final selection = 5 variables; n/p ratio = 20.8).
Tabla 1: Variables incluidas en el modelo. (Método: ridge_iter; n = 104 observaciones; 147 variables iniciales; sin filtrado de colinealidad; selección final = 5 variables; relación n/p = 20,8).

Code	Description	Category	Included in final model
Mat_den	Dense shrublands	Land cover / Habitat structure	Yes
CTI	Topographic Wetness Index	Topography / Soil moisture	Yes
C_forest_total	Total forest cover	Landscape structure	Yes
C_forest_den	Dense forest cover	Landscape structure	Yes
ISSum	Mean global solar irradiance in summer	Climate (radiation)	Yes

Figure 1: Colour morphs detected in the province of Seville and surrounding areas. a) Grey morph with wavy zig-zag pattern (Villanueva del Río y Minas). b) Brown morph with angular zig-zag pattern (Arroyo Guadalora).
Figura 1: Morfos de color detectados en la provincia de Sevilla y áreas limítrofes. a) Morfo gris con patrón en zigzag ondulado (Villanueva del Río y Minas). b) Morfo marrón con patrón en zigzag angular (Arroyo Guadalora).

The highest probabilities of presence are concentrated in Sierra Morena (Figure 2), particularly in three specific areas: the Viar Valley between the Pintado and Melonares reservoirs, Sierra del Pimpollar north of the municipality of El Real de la Jara, and the area surrounding the Onza River. To a lesser extent, presence is predicted in the Sierra Sur, with the highest probabilities near Peñón de Algámitas and Pico Terril. Probabilities in the Guadalquivir Valley are practically null and, in any case, always below 0.2. Although no records were compiled there, a small probability of presence exists in forested areas of Villamanrique, consistent with the species' occurrence in nearby areas of the province of Huelva within the Doñana Natural Area (Carmona-González *et al.*, 2024).

The Lataste's viper (*Vipera latastei*) is an extremely rare species and difficult to detect in the province of Seville, which complicates the assessment of its actual occurrence. Therefore, an environmental favorability model can help to better understand its actual distribution. The model indicates that the most important factors determining its presence are shrub density, topographic wetness, forest cover, and summer irradiance (which appears to negatively affect the species' presence). These parameters are consistent with previous knowledge of the species, which prefers dense shrublands with moderate moisture and avoids excessively warm areas (Brito *et al.*, 2003).

The results obtained allow conservation efforts to be focused on areas with the highest probability of species presence, as well as to identify priority locations for future management measures (Only part of the northern mountain range is included within the Sierra Morena de Sevilla Natural

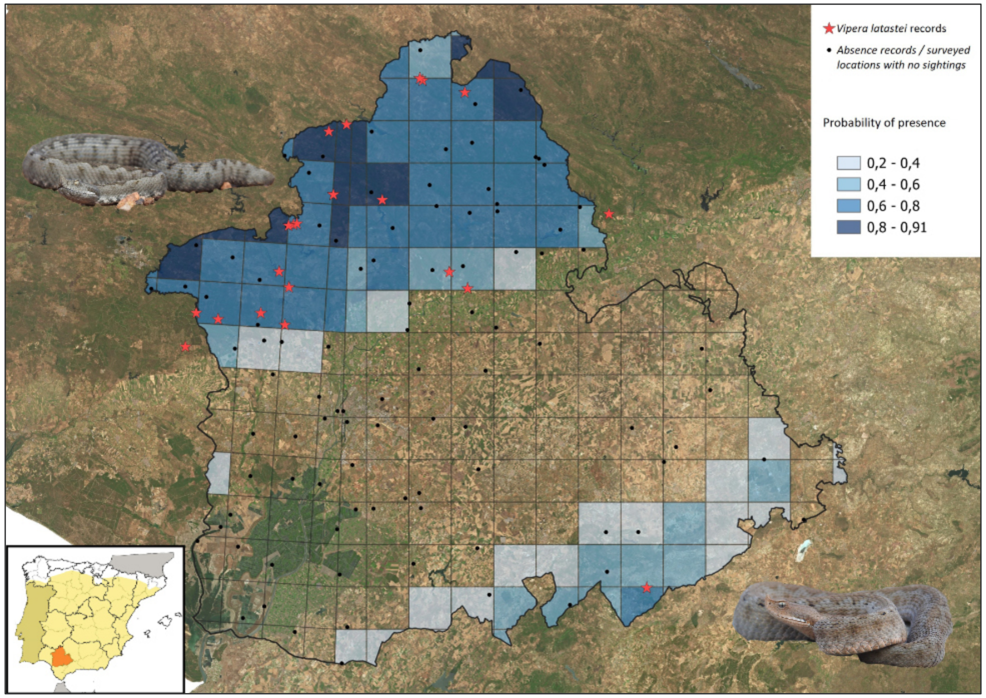

Figure 2: Environmental favourability map for *Vipera latastei* in the province of Seville. The inset map shows the known global distribution of the species (yellow), with the study area highlighted in orange. Brown and grey colour morphs occur intermixed across the study area, with no evidence of spatial segregation or association with zig-zag pattern variation.

Figura 2: Mapa de favorabilidad ambiental para *Vipera latastei* en la provincia de Sevilla. En el minimapa, el área sombreada en amarillo representa la distribución global conocida de la especie. El área de estudio se indica en color naranja.

Park, whereas the southern part remains unprotected). According to the model, the potentially occupied area in the province does not exceed 6,054 km^2 even in the most optimistic scenario (probabilities > 0.2), representing approximately 43 % of the provincial territory. When considering only probabilities above 0.5, the estimated area decreases to 4,327 km^2 (31 %). Finally, by weighting each grid cell by its probability of presence, the estimated area is adjusted to 3,479 km^2, equivalent to 25 % of the provincial territory, which appears to represent the most realistic scenario.

It is essential to further our understanding of the species, particularly through the development and application of a standardised method that enables systematic monitoring over time. Having temporally comparable tools is crucial for estimating population trends, detecting changes in distribution or abundance, and evaluating the effectiveness of conservation measures. This approach would facilitate evidence-based decision-making and contribute to the long-term preservation of the species within its distribution areas.

References

Brito, J.C. 2003. Seasonal variation in movements, home range, and habitat use by male *Vipera latastei* in northern Portugal. *Journal of Herpetology*, 37(1): 155–160.

Carmona-González, R., Carro, F., González de la Vega, J.P. & Martínez-Freiría, F. 2024. Temporal range dynamics of the Lataste's Viper (*Vipera latastei* Boscá, 1878) in Doñana (Spain): Insights into anthropogenically driven factors. *Animals*, 14(20): 3025.

Friedman, J., Hastie, T. & Tibshirani, R. 2010. Regularization paths for generalized linear models via coordinate descent. *Journal of Statistical Software*, 33: 1–22.

Martínez-Freiría, F., Freitas, I., Velo-Antón, G., Lucchini, N., Fahd, S., Larbes, S. *et al.* 2021. Integrative taxonomy reveals two species and intraspecific differentiation in the *Vipera latastei–monticola* complex. *Journal of Zoological Systematics and Evolutionary Research*, 59(8): 2278–2306.

Martínez-Freiría, F., Sillero, N., Lizana, M. & Brito, J.C. 2008. GIS-based niche models identify environmental correlates sustaining a contact zone between three species of European vipers. *Diversity and Distributions*, 14(3): 452–461.

Observation.org. 2025. *Vipera latastei* -Datos de observación. <https://www.observation.org> [Accessed: December 17, 2025].

Pleguezuelos, J.M. & Santos, X. 2002. *Vipera latastei* – Víbora hocicuda. *In*: Pleguezuelos, J.M., Márquez, R. & Lizana, M. (eds.). *Atlas y Libro Rojo de los Anfibios y Reptiles de España*. 587. Dirección General de Conservación de la Naturaleza. Madrid. España.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing. Vienna. Austria. <https://www.R-project.org/> [Accessed: December 17, 2025].

Real, R., Barbosa, A.M. & Vargas, J.M. 2006. Obtaining environmental favourability functions from logistic regression. *Environmental and Ecological Statistics*, 13(2): 237–245.

Rodríguez-Rodríguez, E.J., Carmona-González, R. & García-Cardenete, L. 2018. Actualización de la distribución de los reptiles en la provincia de Sevilla. *Boletín de la Asociación Herpetológica Española*, 29(2): 46–53.

SEO/BirdLife. 2022. III Atlas de aves en época de reproducción en España. <https://atlasaves.seo.org/> [Accessed: December 17, 2025].