European Journal of Ecology, 2024, 109-115

TEMPORAL CHANGES IN THE DISTRIBUTION AND DENSITY OF THE IBERIAN GREY SHRIKE *LANIUS MERIDIONALIS* IN SOUTHERN FRANCE FROM A SPATIAL ANALYSIS COVERING 1994-2023

Frédéric Labouyrie

f.labouyrie@orange.fr

Abstract.

The Iberian grey shrike, Lanius meridionalis, breeds exclusively in Mediterranean France and on the Iberian Peninsula, where its preferred habitats include a mix of agricultural lands and evergreen oak forests. Despite maintaining a strong presence in certain areas, the species has faced many challenges due to environmental changes, agricultural intensification, and habitat alteration, earning it a place on the IUCN Red List of Threatened Species. This study presents an in-depth spatial analysis of the distribution and density of the Iberian grey shrike Lanius meridionalis in southern France, spanning 30 years from 1994 to 2023. We applied spatial mapping methods and kernel density analysis to examine changes in the spatial distribution of this species. Our results suggest a 47% reduction in its home range since 1994 and fragmentation in the southern part of its distribution area, distinguishing it from its Iberian stronghold.

Keywords: *Iberian Grey Shrike, Observational data, Population density, Spatial distribution, France*

Introduction

The Iberian grey shrike, *Lanius meridionalis*, is a distinct member of the family *Laniidae* and is specific to the diverse open landscapes of the western Mediterranean, including southern France and the Iberian Peninsula. This passerine bird, measuring 24-25 cm and weighing between 48-93 grams, is characterized by its stately shrike shape and relatively long tail, making it conspicuous in its habitat. The species features a distinctive black mask extending from the eyes to the posterior ear coverts, contrasted by a narrow white supercilium. Its plumage features dark grey upperparts, white underparts with a light pink-grey coloration, and a characteristic black tail with white tips on the outer feather peninsula (Hernández, 2020; Lefranc & Worfolk, 2022; Yosef, 2020).

The Iberian Grey Shrike inhabits the Iberian Peninsula and Southern France, thriving in open, sunny lowlands up to altitudes of about 1200 m, adorned with thorny bushes (Lefranc & Worfolk, 2022) (Figure 1). Its preferred habitats include a mix of agricultural lands (e.g., for cereal production, vineyards, orchards, and pastures) and evergreen oak forests, indicating its adaptability and specific ecological requirements. The species' dependence on these habitats underscores the importance of understanding its distribution and density patterns for effective conservation strategies (Hernández, 2020).

Lanius meridionalis is primarily an insectivore but also eats small vertebrates. Its foraging strategy often involves impaling prey on thorns or barbed wire, a characteristic behaviour among shrikes. This strategy reflects its unique ecological niche and influences its habitat and prey preferences (Hódar, 2006; Lepley et al., 2004). *Lanius meridionalis* presents an intriguing case study in avian taxonomy and ecology. Historically, it was treated as conspecific with *L. excubitor*, while recent studies have advocated for its recognition as a distinct species based on apparent morphological, behavioural, and ecological differences. Since 1993, in France, the Southern (*Lanius elegans meridionalis)* and Northern Great Grey Shrike (*Lanius excubitor excubitor*) are considered two distinct species

Figure 1: Map showing the Iberian grey shrike *Lanius meridionalis* distribution in France and Spain (green: year-round, blue: likely winter presence). Arrows indicate possible winter migration routes (from Lefranc & Worfolk, 2022). In red is the study area.

with parapatric distributions, i.e., they occupy adjacent but non-overlapping ranges without any known hybridization zone (Isenmann & Bouchet, 1993).

Recent molecular studies have provided critical insights into the taxonomic relationships within the Great Grey Shrike complex (Klassert et al., 2008; Olsson et al., 2010; Poelstra, 2010). The mitochondrial gene tree suggests a non-monophyly of the *Lanius excubitor* complex. Based on morphological, ecological, and geographical data, it challenges the traditional bifurcation into northern (*L. excubitor*) and southern (*L. meridionalis*) species. Furthermore, these studies highlighted the existence of at least six potential species within the complex, including *L. borealis, L. elegans, L. excubitor, L. lahtora, L. meridionalis,* and *L. uncinatus*. However, the authors noted difficulties delineating clear taxonomic boundaries due to the recent divergence and close genetic relationships among these taxa.

The taxonomic recognition of *Lanius meridionalis* as a separate species is not merely a matter of nomenclature but has profound implications for its conservation. With its distribution limited to the western Mediterranean region, understanding its population dynamics, distribution changes, and habitat preferences is vital for effective conservation strategies. Clarifying its status as a separate species underscores the need for targeted conservation efforts and habitat management.

Despite its robust presence in certain areas, the Iberian Grey Shrike has faced challenges due to environmental changes, agricultural intensification, and habitat alteration. Being on the IUCN Red List of Threatened Species, it is classified as vulnerable on a global scale. It breeds exclusively in southern France and the Iberian Peninsula (BirdLife International, 2017; Infante & Hernández, 2018). In Spain, which hosts about 95% of the global population, the species continues to experience a significant decline, with recent annual rates averaging about -5.1% between 1998 and 2019, thus causing a cumulative decrease of 67% over the 21 years (Octavio Infante *pers. com.*; SEO/BirdLife, 2017). In Portugal, population trends are also negative, with a 13 to 40% decrease between 2004 and 2011 (Alonso pers.com; Equipa Atlas, 2022). The national breeding population in France is estimated to be between 550 and 1150 pairs, with a significant decline of 40% between 1993 and 2013 (Hameau et al., 2015).

The primary objective of this study is to examine and characterize changes in the spatial distribution and density of the Iberian Grey Shrike, *Lanius meridionalis,* between 1994 and 2023 in France. It shares no overlap or hybridization zone with its northern counterpart in this region. Our research follows recent taxonomic revisions and seeks to provide updated information on the species' spatial ecology, thereby contributing to conservation efforts and facilitating a better understanding of biodiversity in the Mediterranean region. We employ spatial mapping techniques, kernel density analyses, and other spatial statistical methods to understand how the species distribution and density have evolved.

Methods

Study Area

The study covers various regions in France, focusing on the Iberian Grey Shrike's habitats in the Mediterranean climate zones, specifically in the Occitania and Provence-Alpes-Côte d'Azur regions. Strictly adhering to the Mediterranean climate, the Iberian Grey Shrike is present in France during the breeding season (approx. 1 March to 31 August) in diverse habitats along the Mediterranean coast. These include agricultural plains of "steppe-like" vineyards with low hedges (brambles, *Rubus sp.)* in the Languedoc region and areas of dry cultivation at supra-Mediterranean altitudes in the Provence region, semi-steppe lands of Crau, and grazed mid-altitude areas (up to 1600m in Causses and Cerdagne). The study also covered karst plateaus with Kermes oak *Quercus coccifera* and regions that experience fires (Hameau et al., 2019). The wide range of landscapes offers comprehensive insights into the species' distribution and density changes and provides a robust 30-year dataset for spatial analysis (Hameau et al., 2015).

Data Collection

Observational data were extracted from the collaborative data portal Faune-France (faune-france.org), an online participatory database containing observational data for a range of taxonomic groups, including birds, mammals, reptiles, amphibians, and insects, compiled by both occasional naturalists and professionals using standardized protocols. The collected data are regularly synthesized into reference works (atlases, red books, species fact sheets, habitat fact sheets) and used in various studies (national action plans, local biodiversity atlases, green and blue infrastructure projects).

We extracted all observations of the Iberian Grey Shrike from 1994 to 2023 from this database, including the spatial coordinates of sightings during the estimated breeding period from 1 March to 31 August each year (N = 20,100 data points).

Data Analysis

We divided our study into four time periods, namely: 1994-2004, roughly corresponding to the pre-internet period, i.e., without widescale public access to high-speed internet and therefore without any online data collection platforms where lay naturalists could report their sightings; 2005-2014, a period roughly coinciding with the advent of high-speed internet for all and a growing involvement of the general public (citizen science); 2015-2019, coinciding with the duration of a French national action plan and associated monitoring protocol for Shrike conser-

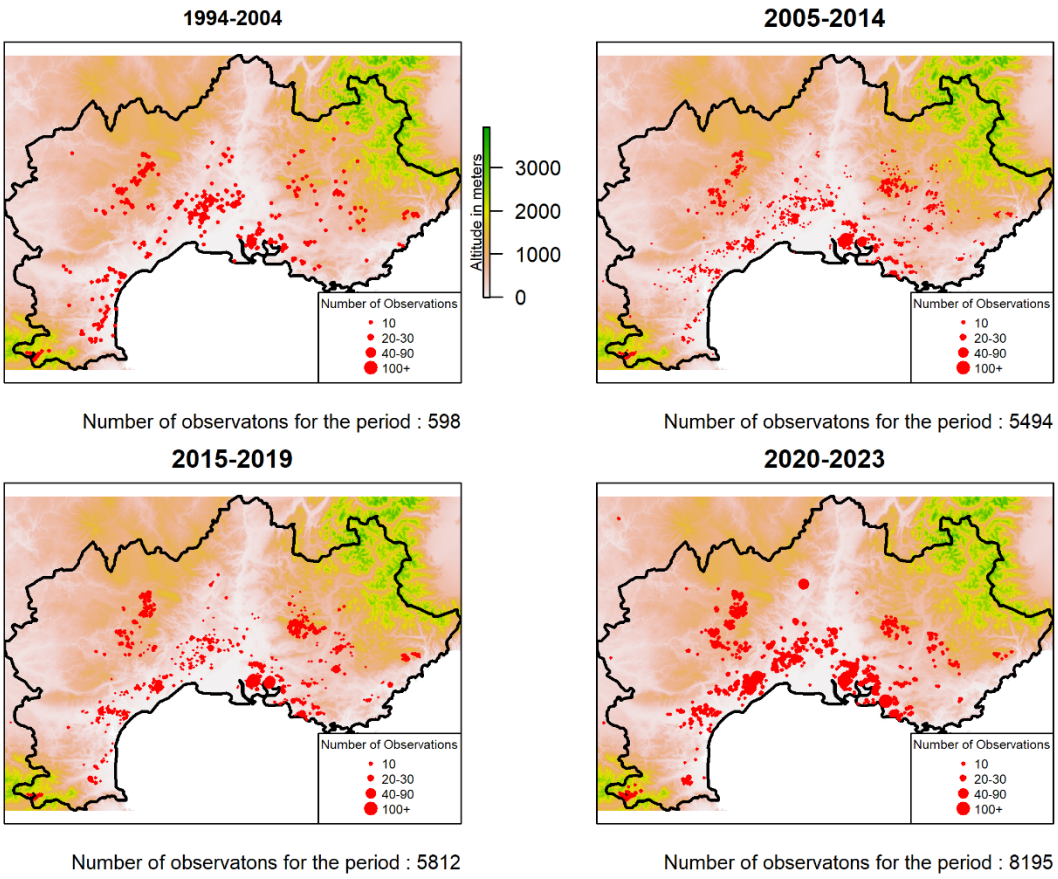

Figure 2: Temporal evolution of the spatial distribution of Iberian grey shrike (*Lanius meridionalis*) sightings during the breeding season in southern France. (Fig. 1 shows the location of the study area in its European context)

vation (Lefranc & Issa, 2013); and finally 2020-2022, the most recent post-action plan period. This division allows us to examine temporal variations in response to broader societal and political changes.

The data analysis involved several statistical and spatial mapping methods, including kernel density estimation (KDE). The spatial coordinates of yearly sightings were binned into spatial grid boxes (grid size: 10x10 km) overlaid onto the habitat map to visually assess temporal variations in their spatial distribution.

We employed KDE to generate smoothed heat maps of Shrike distributions using the *kernelUD* function (v. 0.4.21) from the *adehabitatHR* R package. This process involved creating spatial points and kernel density estimates that were cropped and masked to the study area (Worton, 1989; Seaman & Powell, 1996 .

We also conducted a Density-Based Spatial Clustering of Applications with Noise (DBSCAN) analysis using the *dbscan* R package, which allowed us to detect and visualize clusters based on the density of sighting locations (Ester et al., 1996). This type of analysis highlights the main active areas by filtering out one-off observations, which are considered noise.

Results

Distribution of Sightings

Between 1994 and 2004, there were only a few recorded observations, followed by a 10-fold increase between 2005 to 2014, likely due to increasing public engagement (see Section 2.3), and another marked increase after 2015, possibly due to the implementation of a French national action plan and associated systematic monitoring effort (Figure 2). The number of sightings further increased during the most recent period, 2020-2023, with the yearly average number of sightings nearly doubling compared to the preceding period.

Density of Sightings during the Breeding Season

The heat maps illustrate the spatial and temporal distribution of Shrike sightings during the breeding period (Fig. 3) and changes in sighting density over time. While these maps visualize the frequency of sightings rather than the actual population density and likely include bias due to observer activity (areas more accessible or popular with observers produce more sightings), they do illustrate some shifts in breeding hotspots, also from more coastal to inland areas over the four time periods.

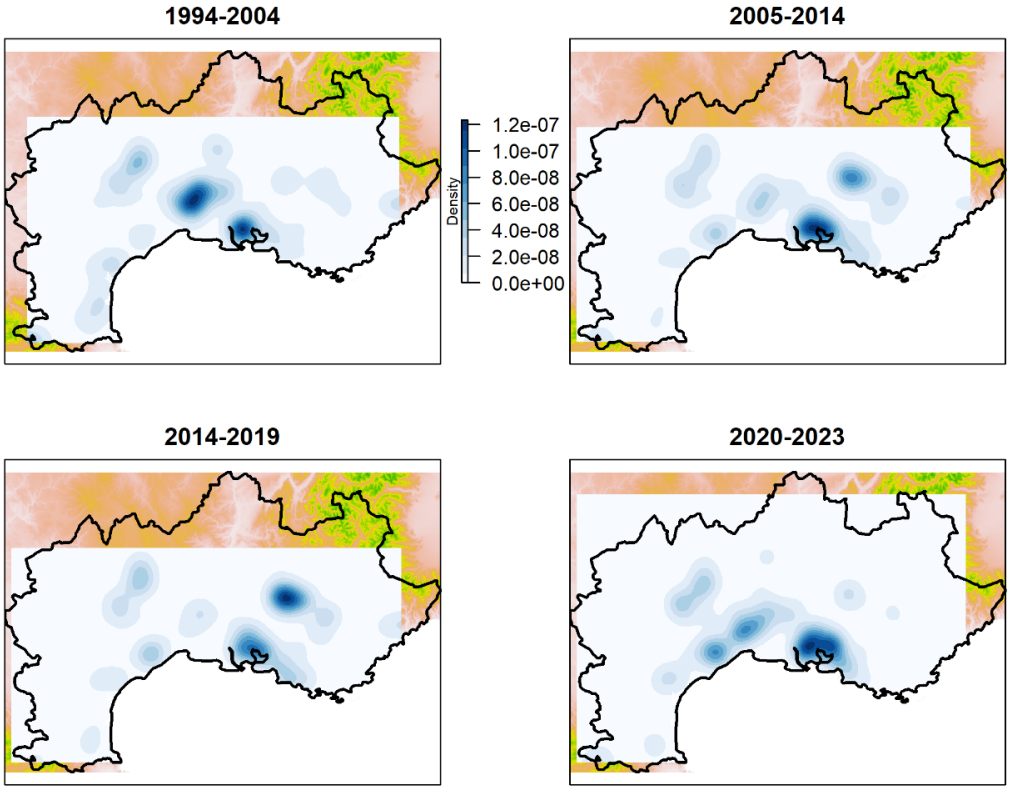

Figure 3: KDE heat maps of the sightings of the Iberian grey shrike (*Lanius meridionalis*) during the breeding season in southern France from 1994 to 2023.

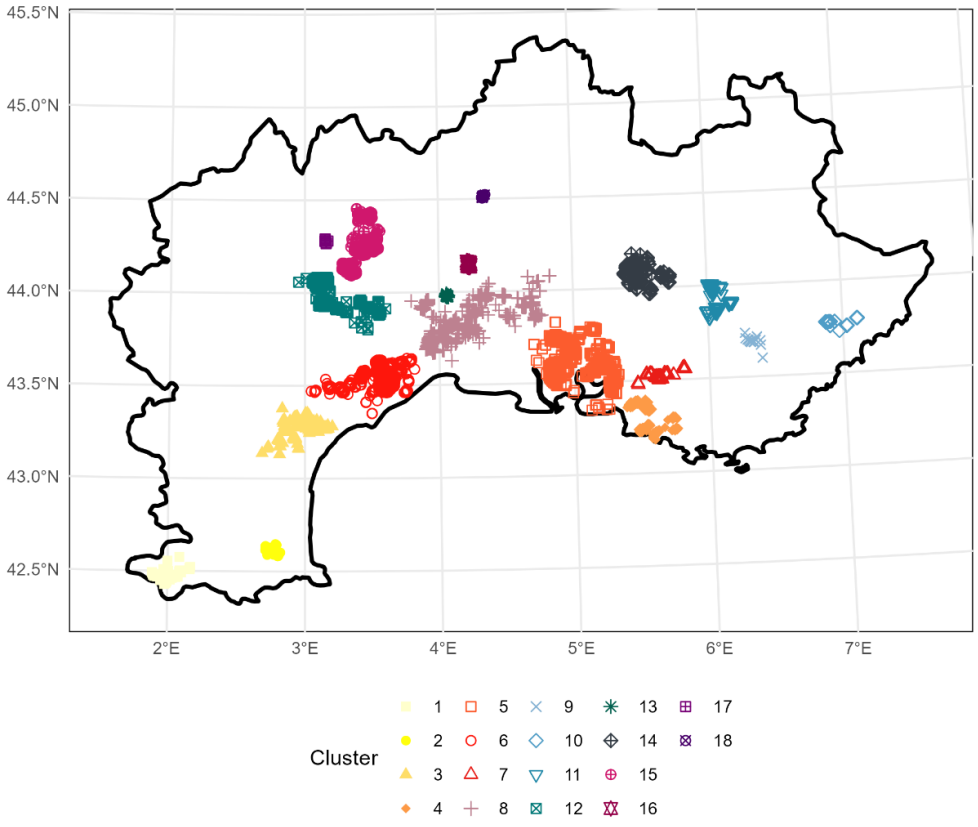

Figure 4: Cluster Analysis of Iberian Grey Shrike Observations in Southern France from 2020 to 2023.

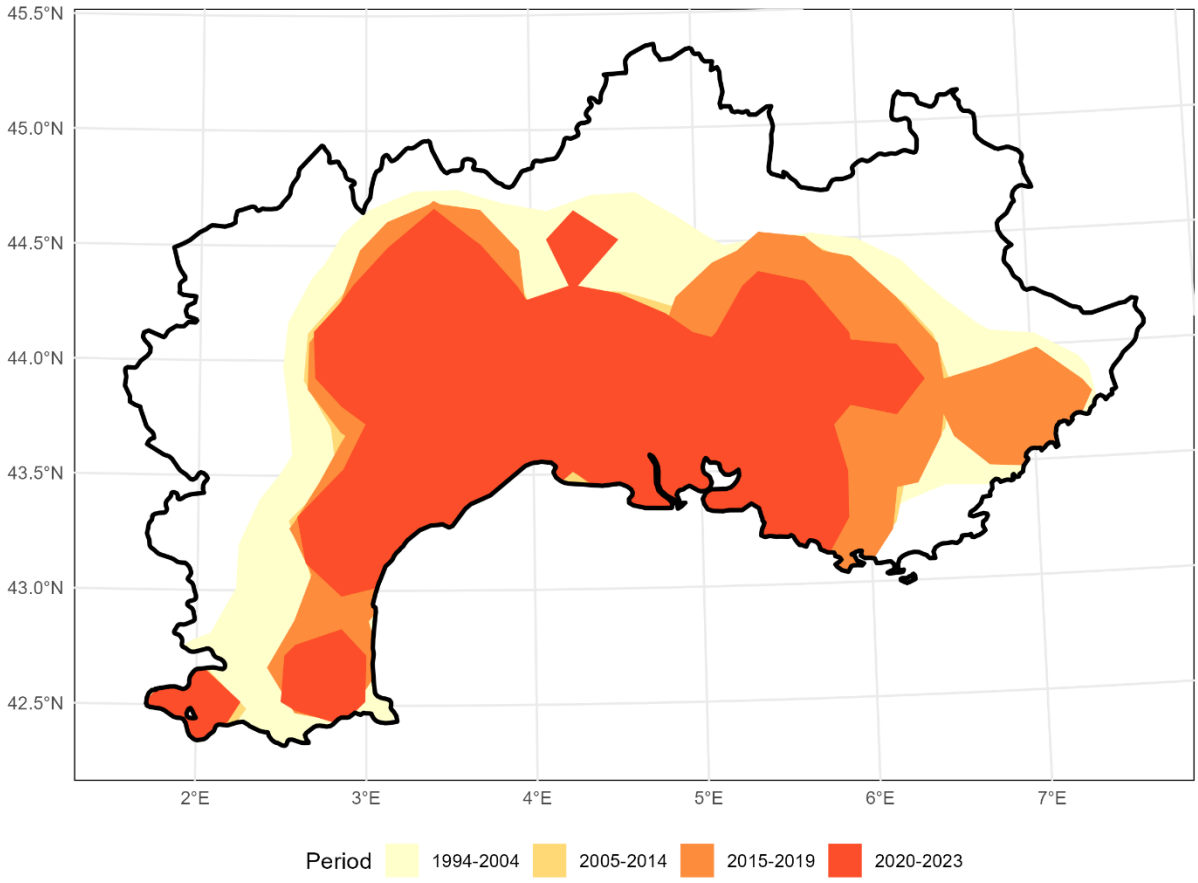

Figure 5: Temporal variation in the home range of the southern grey shrike (*Lanius meridionalis*) in southern France during four time periods between 1994 and 2023.

Clustering Analysis

During the most recent period, 2020-2023, a DBSCAN analysis based on the proximity of Southern Shrike sightings shows the presence of 18 distinct clusters in the study area (Figure 4). By marking isolated observations as noise, this technique indicates the fragmentation of the population into smaller groups, which tend to be more concentrated and closer together in the central part of the study area. At the same time, clusters are more dispersed in the map's southwestern (Catalan plain) and eastern (Provence-Alpes-Côte-d'Azur and Camargue) extremes.

Temporal Changes in Home Range

The calculated home ranges for each period show a notable decrease in areas over time. Using 1994-2004 as a reference period, the home range areas are smaller by **33.58%**, **30.93%**, and **47.24%** in the 2005-2014, 2015-2019, and 2020-2023 periods, respectively (Figure 5).

Discussion

In this study, we examined the spatial distribution and density of breeding sites of the Iberian Grey Shrike in southern France, including their temporal changes between 1994 and 2023. Using kernel density estimation and DBSCAN clustering analysis, we could highlight spatial patterns of bird sightings and identify trends in spatial distribution and possible fragmentation within the population.

Interpretation of Results

The results of this study paint a complex picture of the ecological status of the Iberian Grey Shrike in France over the past 30 years. The increasing frequency of observations over time reflects not only the growing conservation efforts and availability of data collection tools but also the growing interest and involvement of ornithological enthusiasts and scientists and their increasing capability to monitor the species. Over the study periods, we observed significant shifts in the distribution and density of the Iberian Grey Shrike. The early period of 1994 to 2003 saw fewer recorded observations, likely due to the species' recent taxonomic reclassification, the unavailability of online data platforms, and a growing interest in avian monitoring (Isenmann & Bouchet 1993). As data collection platforms became more accessible and widely used from 2005 to 2014, there was a significant increase in

reported sightings, reflecting the growing engagement by the birdwatching community, including citizen scientists.

The period from 2015 to 2023 is marked by the implementation of a French national action plan for Shrike conservation. This plan was accompanied by a systematic monitoring effort which resulted in numerous scientific field studies in a wide variety of locations. This, in turn, led to a surge in observations (Lefranc & Issa 2013). This uptick illustrates the effectiveness of structured conservation initiatives in promoting species monitoring.

However, despite the increased observational effort, growing environmental (climate change) and anthropogenic pressures on this species, and its paradoxical lack of spatial homogeneity, we found a significant reduction in the species' home range, nearly halving its distribution area between 1994 and 2023. In addition, despite more uniform spatial coverage by observers and more sightings in recent years (faune-france.org)(FIGURE 2), we found a marked clustering between 2020 and 2023. Populations become sparser and more fragmented, particularly in its range's south-western and eastern extremities, probably separating it permanently from more stable population strongholds on the Iberian Peninsula.

This could indicate ecological pressures, such as habitat loss, agricultural intensification, or climate change, leading to changes in habitat suitability and availability. The increased clustering, combined with a shrinking home range area, particularly post-2014, aligns with these potential pressures, signaling a reduction in suitable habitats or alterations in land-use patterns that could adversely affect the Shrike's ecological niche.

Comparison with Other Studies

Our findings are consistent with broader trends noted in avian populations across Europe. The observed distributional shifts in similar species are often attributed to the transformation of agricultural practices and urban expansion. For example, recent European studies indicated a substantial decline in native avifauna biodiversity, with a 17 to 19% decrease in the overall abundance of breeding birds since 1980, translating to a loss of 560 to 620 million individuals. Specifically, breeding birds in agricultural habitats have suffered a 35% reduction (Burns et al., 2021). Other studies have highlighted the devastating effects of agricultural processes on avian fauna in Europe (Rigal et al., 2023) or the detrimental impact of intensive practices such as the destruction of natural or semi-natural habitats and the effect of pesticides on bird populations (Donald et al., 2001; Hallmann et al., 2014; Moreau et al., 2022).

Ecological and Conservation Implications

The effectiveness of the French national action plan in increasing observations underscores the value of such programs, suggesting that continuous support and funding for these initiatives is pivotal.

Furthermore, the reduction in home range size calls for a reassessment of current habitat management practices. Given this species specific habitat requirements, maintaining a diverse and connected landscape is critical for conserving it. Conservation efforts must be dynamic and should evolve with the changing ecological landscape and species' needs.

Limitations of the Study

Data collection depends on the participation of both amateur and professional naturalists, which could introduce a bias towards more accessible or well-known areas, leading to under-sampling of specific areas. Furthermore, the reliance on observational data means that actual population sizes may not be fully represented, as detection rates can vary with observer skill, effort, and environmental conditions. The spatial resolution of the data also poses constraints on detecting finer-scale habitat preferences and species interactions.

Further Research

Further research should mitigate these limitations by integrating more systematic approaches to conduct surveys, such as point counts or transect surveys, which can provide more standardized data. Remote sensing technologies and habitat modeling could also be employed to understand habitat changes over time better. Collaborations with local conservation organizations might enhance data collection and ensure more consistent monitoring efforts across the Shrike's range. Interdisciplinary studies combining ecological, genetic, and behavioural research would contribute to a more holistic understanding of the species conservation needs.

Acknowledgements

Editorial assistance, in the form of language editing and correction, was provided by XpertScientific Editing and Consulting Services.

Conflicts of Interest

None to declare

References

Equipa Atlas. 2022. III Atlas das Aves Nidificantes de Portugal (2016-2021). SPEA, ICNF, LabOr/UÉ, IFCN. Portugal. https://www.listavermelhadasaves.pt/atlas/lanius-meridionalis/

BirdLife International. 2021. *Lanius meridionalis (Europe assessment)*. *The IUCN Red List of Threatened Species* 2021: e.T22729533A200216423. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22729533A200216423.en. Accessed on 16 January 2024.

Burns, F., Eaton, M. A., Burfield, I. J., Klvaňová, A., Šilarová, E., Staneva, A., & Gregory, R. D. 2021. Abundance decline in the avifauna of the European Union reveals cross-continental similarities in biodiversity change. Ecology and Evolution, 11, 16647–16660. https://doi.org/10.1002/ece3.8282

Donald P. F., Gree R. E. & Heath M. F. 2001. Agricultural intensification and the collapse of Europe's farmland bird populations. *Proc. R. Soc. Lond. B.* **268**(1462):25-29. https://doi.org/10.1098/rspb.2000.1325

Equipa Atlas. 2022. III Atlas das Aves Nidificantes de Portugal. 2016-2021. SPEA, ICNF, LabOr/UÉ, IFCN. Portugal. https://www.listavermelhadasaves.pt/atlas/lanius-meridionalis/

Ester, M., Kriegel, H. P., Sander, J., & Xu, X. 1996. A density-based algorithm for discovering clusters in large spatial databases with noise. In KDD-96 Proceedings, 226-231. https://dl.acm.org/*doi/10.5555/3001460.3001507*

Hallmann C., Foppen R., Van Turnhout C. et al. 2014. Declines in insectivorous birds are associated with high neonicotinoid concentrations. *Nature* **511**:341-343. https://doi.org/10.1038/nature13531

Hameau, O., & Gilot, F. 2015. La Pie-grièche méridionale. In Issa, N., & Muller, Y. (Eds.), Atlas des oiseaux de France métropolitaine. Nidification et présence hivernale (p. 13). Delachaux et Niestlé, Paris.

Hameau, O., Alphand, M., Charbonneau, A., & Martin, C. 2019. Étude du territoire de reproduction de la Pie-grièche méridionale en garrigue. Faune-PACA Publication, 91, 13 pp. https://cdnfiles1.biolovision.net/www.faune-paca.org/userfiles/FPPubli/FPP91territoirePGMgarriguesV2.pdf

Hernández, A. M. (2020). Alcaudón real – *Lanius meridionalis*. In: Enciclopedia Virtual de los Vertebrados Españoles. López, P., Martín, J., Moreno-Rueda, G. (Eds.). Museo Nacional de Ciencias Naturales, Madrid. http://www.vertebradosibericos.org/

Hódar, J. A. 2006. Diet composition and prey choice of the southern grey shrike *Lanius meridionalis* L. in South-Eastern Spain: the importance of vertebrates in the diet. *Ardeola* **53**:237-249. https://api.semanticscholar.org/CorpusID:49227786

Isenmann, P., & Bouchet, M. A. 1993. L'aire de distribution et le statut taxonomique de la Pie-grièche grise méridionale *Lanius elegans meridionalis*. *Alauda* **61**:223-227. https://api.semanticscholar.org/CorpusID:132239640

Kie, J. G., Matthiopoulos, J., Fieberg, J., Powell, R. A., Cagnacci, F., Mitchell, M. S., Gaillard, J. M., & Moorcroft, P. R. 2010. The home-range concept: are traditional estimators still relevant with modern telemetry technology? *Phil. Trans. R. Soc. B* **365**(1550):2221-2231. https://doi.org/10.1098/rstb.2010.0093

Klassert, T. E., Hernández, M. A., Campos, F., Infante, O., Almeida, T., Suárez, N. M., Pestano, J., & Hernández, M. 2008. Mitochondrial DNA points to *Lanius meridionalis* as a polyphyletic species. *Mol. Phylogenet. Evol.* **47**(3):1227-1231. https://doi.org/10.1016/j.ympev.2008.03.012

Lefranc, N., & Issa, N. 2013. Plan national d'actions: Pies-grièches *Lanius spp*. 2014-2018. Ministère de l'Écologie, du Développement durable et de de l'Énergie. La Défense, France, 144 pp.

Lefranc, N., & Worfolk, T. 2022. Shrikes of the World. Bloomsbury Publishing, London, UK, 366 pp.

Lepley, M., Thevenot, M., Guillaume,C.P., Ponel, P. & Bayle, P. 2004. Diet of the nominate Southern Grey Shrike *Lanius meridionalis meridionalis* in the north of its range (Mediterranean France), Bird Study, 51:2, 156-162, DOI: 10.1080/00063650409461347

Moreau, J., Rabdeau, J., Badenhausser, I., Giraudeau, M., Sepp, T., Crépin, M., Gaffard, A., Bretagnolle, V., & Monceau, K. 2022. Pesticide impacts on avian species with special reference to farmland birds: a review. *Environ. Monit. Assess.* **194**(10):790. https://doi.org/10.1007/s10661-022-10394-0

Olsson, U., Alström, P., Svensson, L., Aliabadian, M., & Sundberg, P. 2010. The *Lanius excubitor* (Aves, Passeriformes) conundrum - Taxonomic dilemma when molecular and non-molecular data tell different stories. *Mol. Phylogenet. Evol.* **55**:347-357. https://doi.org/10.1016/j.ympev.2009.11.010

Poelstra, J. 2010. Trends in systematics. Speciation in shades of grey: the great grey shrike complex. *Dutch Birding* **32**(4):258-264. https://api.semanticscholar.org/CorpusID:195751670

Rigal, S., et al. 2023. Farmland practices are driving bird populations decline across Europe. *PNAS* **120**(21):e2216573120. https://doi.org/10.1073/pnas.2216573120

Seaman, D. E., & Powell, R. A. 1996. An Evaluation of the Accuracy of Kernel Density Estimators for Home Range Analysis. *Ecology* **77**:2075-2085. https://doi.org/10.2307/2265701

SEO/BirdLife. 2017. Programas de seguimiento y grupos de trabajo de SEO/BirdLife 2016. SEO/BirdLife. Madrid. https://seo.org/boletin/seguimiento/boletin/2016/html5forpc.html

Worton, B. J. 1989. Kernel Methods for Estimating the Utilization Distribution in Home-Range Studies. *Ecology* **70**:164-168. https://doi.org/10.2307/1938423

Yosef, R., ISWG International Shrike Working Group, C. J. Sharpe, J. S. Marks, & G. M. Kirwan 2020. Iberian Gray Shrike (*Lanius meridionalis*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, & E. de Juana, eds.). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.ibgshr1.01