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Home ranges and habitat use/selection

Wintering habitat selection of Eurasian stone-curlew in Southwest Iberia revealed by high-resolution movement and remote-sensing data

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Human-dominated landscapes hold high levels of biodiversity but are under rapid change. Understanding how animals move and where they perform their year-round vital activities at a fine scale is crucial to make recommendations on land-use management in these complex ecosystems. Here we combined high-resolution movement and remote-sensing data to describe the wintering habitat of a rather elusive farmland bird, the Eurasian stone-curlew *Burhinus oedichnemus*. Following 12 GPS-tracked birds for 3 winter seasons, we investigated the selection of wintering roosting and feeding areas in Southwest Iberia, using land-use, topographic, and remote-sensing variables from both optic and radiometric sensors with a resolution of up to 10m (Sentinel 1 and 2 Satellites). While both were in low-inclined runoff areas with low vegetation, roosts were in the less productive or drier/rocky portions of open crops or grasslands, and often near roads or anthropogenic areas. On the other hand, feeding occurred in areas with homogeneous tree cover, mainly in olive plantations. Little was known about the roosting and feeding habitats of stone-curlews during winter, and this study provides novel insights on how this threatened bird moves and uses different habitats within a complex agricultural landscape.

Use and Selection of Ponds in Semi-Arid Sympatric Sandgrouse: *Pterocles alchata*, and *Pterocles orientalis*.

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Black-bellied sandgrouse, *Pterocles orientalis*, and the pin-tailed sandgrouse, *Pterocles alchata*, exist in sympatry and allopatry under analogous environmental contexts. Most frequently found in semi-arid environments, the pin-tailed and black-bellied sandgrouse are typical inhabitants of the less xeric habitats within the range of *Pterocles*. Because of their unique adaptation for water transport and the crucial importance of water sources for breeding sandgrouse, conservation efforts require an understanding of the characteristics of selected ponds. The aim of this project is to characterize how these two species of sandgrouse use ponds and to determine what features make some ponds more favorable than others.

The locations of 81 individuals (41 *P. orientalis*; 40 *P. alchata*) were tracked throughout Spain and Portugal between 2021-2023. This study focuses on the individual's visitation to the ponds distributed across the three study areas: SPA of Castro Verde, Parque Natural do Vale do Guadiana, and the SPA of La Serena. A total of 4735 ponds were identified as potential watering sources for wildlife.

This study will address fundamental questions pertaining to how ponds are utilized by the sandgrouse throughout the year, what are the environmental factors influencing pond selection, and how it will influence nest site selection. For the first part of the work, we will be looking at how often sandgrouse are using the ponds during breeding (May-September) and non-breeding (November-April) seasons. To further elucidate our understanding of how the birds are using these water sources, species and sex will be compared to investigate the needs of the individuals.

Home range studies in six steppe bird species: a review of research questions, estimation methods and implications for solar photovoltaic energy development

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El desarrollo de la energía solar fotovoltaica ha crecido rápidamente durante las últimas décadas en la península ibérica. Estas infraestructuras ocupan grandes extensiones de territorio agroestepario y, por lo tanto, pueden tener significativas implicaciones en la conservación de las aves esteparias, provocando la reducción del hábitat de muchas especies. Con el fin de evaluar a qué escala paisajística las plantas fotovoltaicas pueden impactar en las poblaciones de 6 especies de aves esteparias amenazadas (sisón común, ganga ibérica, ganga ortega, aguilucho cenizo, cernícalo primilla y alcaraván), realizamos una revisión bibliográfica sistemática acerca del conocimiento actual sobre sus áreas vitales. El objetivo es entender las variaciones espaciotemporales de estas áreas y detectar lagunas de conocimiento relacionadas con las especies, áreas geográficas o periodos del ciclo vital menos estudiados. Asimismo, la revisión pretende extraer información sobre las técnicas de seguimiento y de análisis de datos utilizadas para calcular áreas vitales y detectar sesgos asociados a ellos. En la presentación de la I Jornada Técnica del GIAE, se mostrarán los resultados de esta revisión y se presentarán otros objetivos de investigación abordados en este estudio.

Movement and feeding ecology

Corredores migratorios del sisón común (*Tetrax tetrax*) en la Península Ibérica

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Los avances en tecnología han permitido reducir el tamaño de los dispositivos GPS, reduciendo el impacto sobre el ave marcada, y aumentar la resolución de los datos recogidos. Estos datos permiten analizar la ecología espacial de las especies marcadas y así caracterizar las zonas de invernada, de reproducción y los corredores migratorios que las conectan. Desde 2019 se han marcado con este tipo de dispositivos ejemplares de sisón común (*Tetrax tetrax*) en la Península Ibérica, más concretamente en Zamora (9), Madrid (1), Toledo (4), Extremadura (1) y Sevilla (6). Esta especie ha sufrido un marcado declive en las últimas décadas que ha propiciado su reclasificación en el Catálogo Nacional de Especies Amenazadas de vulnerable a en peligro por lo que identificar sus cuarteles de cría e invernada y los corredores migratorios que utilizan es indispensable para conservar su hábitat y reducir la mortalidad asociada a la migración. En esta comunicación describimos el comportamiento migratorio de los ejemplares marcados, identificando patrones de movimiento residentes y migradores, así como los corredores migratorios de estos últimos, calculados a partir funciones *kernel*s de puente browniano.

Latest findings in knowledge of diet and trophic interactions of sympatric bustards and sandgrouse

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Knowledge on feeding ecology of declining species, such as steppe birds, is essential to address their conservation requirements. In the last years, we have carried out different studies using DNA metabarcoding from faeces to characterise the diet of some threatened steppe birds in autumn, winter, and spring, with the aim of better understanding their dietary requirements, trophic interactions and potential threats. Our first results showed that these species' diets mostly consisted of plants and seeds, although arthropods were also relevant to certain species like bustards. However, we now know that these results probably underestimated the number of arthropods. Among arthropods, we found some previously unreported taxa, such as thrips, arachnids, and springtails, and some taxa that could be used as antiparasitic food. We found seasonal and interspecific differences in the vegetal components of the diet, with greater importance of cultivated plants during autumn and winter (around 50% of their diet) than during spring. Furthermore, these results also showed a dietary niche partitioning, with a marked segregation between bustards. Diet similarity was generally higher between species from different orders that occur in mixed-species flocks. This partitioning was probably related to a stratification in habitat use rather than to specialization and might be a strategy to minimize interspecific competition.

Conservation threats

Heatwaves impair reproduction in a Mediterranean raptor

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Future climatic scenarios forecast increments in average temperatures, and in frequency and magnitude of heatwaves. Whereas animals' behavioural adjustments could buffer direct physiological and fitness costs of exposure to excessive ambient temperature (T_a), such an option may not exist during specific phases of the life cycle (e.g. early nest stages). We investigated the effects of extreme air temperatures (T_{air}) on reproduction (hatching success, nestling survival and morphological development) in the lesser kestrel (*Falco naumanni*) by performing a nest cooling experiment. Nestboxes were shaded to prevent direct sunlight exposure, achieving a reduction of ca. 4°C compared to control nestboxes. Hatching success declined with increasing T_a , where maximum temperatures in the nest above 44°C predicted a >50% hatching failure. Shading markedly reduced nestling mortality during heatwaves (~10% vs. ~55% in control nestboxes) and enhanced early nestling growth. Our results demonstrate that heatwaves occurring during the breeding period can have strong negative impacts on different components of avian reproduction, from egg hatching to nestling fledging. More broadly, these findings suggest that the projected future increases of summer temperatures and heatwaves frequency in the Mediterranean basin and elsewhere in the Northern Hemisphere may threaten the local persistence of even relatively warm-adapted species.

Effect of light and noise associated with wind farms on Dupont's lark populations

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Wind energy poses a great threat to the conservation of shrub steppes and its bird community. Specifically, wind turbines negatively affect Dupont's lark (*Chersophilus duponti*) populations, with these impacts being detectable up to 4.5 km. The mechanisms underlying these impacts are unknown, but light and noise pollution have been suggested as potential drivers because they can trigger spatial displacement and induce changes in the behaviour and physiology of individuals. In this work, we evaluated the effect of noise and lights associated with wind turbines on the probability of occurrence and space use patterns of the Dupont's lark between 2008 (1-year prior to wind farm installation) and 2019 (8-10 years after). Model comparison using Akaike's information criterion (AICc) showed that the models that incorporated light as predictor were better candidates than those incorporating wind farms noise. In addition, Partial Least Square regressions (PLSR) confronting all predictors showed that light explained 0.9% and 1.8% of the variance in occurrence probability and space-use patterns, respectively, while noise associated to wind turbines had no effect. Overall, lights associated to wind turbines negatively impacted on Dupont's lark populations. Further experimental studies are needed to better understand the mechanisms that explain the negative impact of aircraft warning lights installed at wind turbines on bird populations.

Management strategies

Los efectos de varias prácticas agrícolas sobre la comunidad de artrópodos en barbechos

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Los artrópodos forman parte de la dieta de varias especies de aves esteparias, como el sisón o el alcaraván, y en especial de sus crías durante la época de crecimiento. Por ello, la reducción de la disponibilidad de artrópodos se ha relacionado con el descenso de las poblaciones de estas aves.

En este trabajo, usamos una aproximación experimental para explorar el efecto de varias prácticas agrícolas (labrado, picado, plantado de alfalfa y control) sobre la biomasa de varios taxones de artrópodos en barbechos gestionados para la conservación de aves esteparias. Mediante *path analysis* evaluamos los efectos directos e indirectos (mediados por la estructura de la vegetación) de los tratamientos.

El picado y el labrado tuvieron efectos negativos leves sobre la biomasa de artrópodos respecto al control, mediados por diferencias en la vegetación. Para los ortópteros, el labrado fue el tratamiento con el efecto negativo más importante, tanto directo como consecuencia de una menor altura de la vegetación. Las arañas también se vieron afectadas por la disminución de la altura de vegetación. Sin embargo, los tres tratamientos tuvieron impactos positivos sobre la biomasa de coleópteros respecto al control. Nuestros resultados son relevantes para una gestión que favorezca las comunidades de artrópodos.

La ganadería extensiva en los páramos esteparios mediterráneos y su efecto en las comunidades de aves, coleópteros coprófagos y plantas

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La ganadería en extensivo de ovino tradicionalmente ha modelado paisajes mediterráneos, como las estepas arbustivas ibéricas. En las últimas décadas, el cese de esta y otras prácticas tradicionales ha provocado una drástica transformación de estos paisajes, desencadenando respuestas complejas en distintos grupos taxonómicos y sus comunidades.

En este trabajo se evalúa el efecto de gradientes de carga ganadera sobre la comunidad de plantas, de coleópteros coprófagos y de passeriformes que componen el paisaje estepario arbustivo. Durante la primavera de 2022, se muestrearon zonas con distinta carga ganadera, desde el abandono total hasta un pastoreo moderado, en Zonas de Especial Protección para las Aves (ZEPAs) de Segovia, Cuenca y Guadalajara. Se marcaron un total de 13 rebaños de oveja con GPS para estimar la intensidad de pastoreo. A lo largo de estos gradientes de pastoreo se colocaron un total de 66 estaciones de muestreo, donde se muestreó la comunidad vegetal en cuadrados de 1x1m (estructura de la vegetación y composición florística), la comunidad de coleópteros coprófagos mediante trampas *pitfall* con atrayente de excremento ovino fresco y la comunidad de passeriformes esteparios mediante estaciones de escucha. Para el análisis de estos datos se elaborarán mapas Kernel de intensidad de pastoreo y se evaluará cómo varían las comunidades de los distintos grupos taxonómicos estudiados a lo largo de este gradiente. Los resultados de esta investigación proporcionarán información relevante sobre las consecuencias del abandono del ganado extensivo en la conservación de las comunidades ligadas a ambientes esteparios.

La translocación como herramienta de conservación de un paseriforme estepario en peligro: primeros resultados con la alondra ricotí (*Chersophilus dupontii*)

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Durante el mes de marzo 2023 se inició el primer año de una prueba piloto de translocaciones de alondra ricotí (*Chersophilus dupontii*) en Castilla-La Mancha en el marco del proyecto LIFE Connect Ricotí. Uno de los objetivos del proyecto es testar la viabilidad de los reforzamientos poblacionales como posible medida para la conservación de esta especie en peligro de extinción. Este año se han capturado 11 machos, de los que 6 fueron translocados en una zona con hábitat adecuado, situada a 50 km de distancia, en la que ha habido una continua regresión poblacional en los últimos años. Los otros 5 ejemplares se liberaron en la misma zona de captura como individuos control. Todos los ejemplares (controles y translocados) fueron equipados con radioemisores codificados de 0'9 gr con una vida útil estimada de 2 años. Las aves son monitorizadas de forma continua mediante estaciones de radio seguimiento automático ubicadas tanto en el área de origen como en la de translocación.

Los resultados principales de la translocación fueron: dos individuos translocados desaparecieron de la zona en tan solo un día, desconociendo dónde pudieron moverse. Otros 2 individuos regresaron a la misma zona de origen después de permanecer un mes en el área de translocación. Otro abandonó la zona de translocación aproximadamente 40 días después de su liberación sin conocer su actual paradero. El sexto individuo translocado se encontró muerto, probablemente depredado, en la zona de liberación. Respecto a los individuos control, 3 de los 5 ejemplares desaparecieron de las zonas fuente durante el mes de mayo-junio, otro fue encontrado depredado y el quinto permanece en la zona.

Estos primeros resultados destacan por haber documentado los movimientos de más larga distancia conocidos para la especie (más de 50 km), realizados en plena época reproductiva, y ponen de manifiesto la importancia de comprender los procesos dispersivos de la alondra ricotí para perfeccionar las técnicas de gestión *exsitu* como son las translocaciones.

A spatially explicit Individual Based-Model to support conservation decisions for the Little Bustard in Extremadura, Spain

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Endangered grassland bird species, including the little bustard (*Tetrax tetrax*), have witnessed alarming declines across Europe. The Iberian Peninsula is a stronghold for many of these species, with Extremadura being one of the most important regions for their conservation. A comprehensive understanding of the little bustard's distribution and population dynamics throughout the year is therefore essential for effective conservation planning. To address this challenge, we developed a spatially explicit Individual-Based Model (IBM) that is based on Habitat Suitability Index (HSI) models. At a first stage, we modeled habitat suitability for the little bustard's three phenological stages: winter, breeding, and post-breeding. Leveraging a 12-year GPS telemetry dataset from 91 tagged individuals and high-resolution environmental metrics, we created a phenological HSI at a 250m resolution. These HSI served as the foundation for our IBM to realistically simulate demographic processes, including survival, reproduction, spatial organization, and migration.

HSI identified key environmental factors affecting the species, such as habitat structure, rainfall rates, and air temperatures, highlighting the species vulnerabilities to land use changes and climate fluctuations. Our IBM provided valuable insights into the species' vulnerability. With a skewed sex ratio, low productivity, and survival rates, the little bustard population faces the risk of short-term extinction. Additionally, it identified vital conservation areas and estimated the necessary habitat improvements to halt population decline.

The integration of HSI and IBMs in our study showcases the potential of combining diverse modelling techniques for effective conservation management. This approach contributes to the development of high-resolution decision-support tools for safeguarding endangered species like the little bustard in the face of ongoing environmental challenges.

Tools and technologies for the study of steppe birds

Unlocking the secrets of elusive birds: An experimental approach to identify and study the behaviour of little bustards using accelerometer data

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Recent technological advances, such as tri-axial accelerometry and emergent tracking technologies like GPS and 3D accelerometers (Acc), provide unprecedented opportunities for researchers to remotely monitor and study animal behavior, including bird behavior. These cutting-edge tools enable the acquisition of movement information on key aspects of species' ecology that may be crucial for their conservation. The elusive behaviour of steppe birds presents a challenge in observing and studying their ecology in the wild. Here, we present an experiment conducted on little bustards to identify the Acc signatures of different behaviours (i.e., walking, foraging, resting, male display) using machine learning. This experiment provides the first classification of several behaviours from Acc data in this species. The method developed in this experiment will allow the study of fine-scale behavioural responses of free-ranging birds to changing environmental conditions and provide new knowledge on the strategies they adopt in response to agricultural intensification. The results have practical applications to address an array of conservation issues and open a new window for research on elusive bird species.

Assessing the relationship between satellite-based vegetation indices and arthropod abundance in steppe ecosystems

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Steppes are one of the most vulnerable habitats in Spain, holding singular communities and some of the most threatened bird species. In this group, Dupont's lark situation stands out, as it recently gained the endangered status at national scale. Among the main factors regarding the decline of the species, the potential decrease of arthropods, their main prey, has been widely commented. Here we assess the utility of remote sensing data, a non-invasive method, to evaluate arthropod availability. To do this, we assessed the relationship between several satellite-derived vegetation indices and arthropod abundance and biomass in two habitat patches in the region of Ademuz (Valencia), where Dupont's lark was present. Arthropod abundance was estimated through specific field surveys carried out during the breeding season using pit-fall traps. Due to the reduced small scale of the study area, the different communities of arthropods analysed, and the diverse vegetation indices used in our study, our results offer a deeper insight of the trophic web. This may contribute to evaluate the generality of patterns found in prior research in Iberian steppes and to a better understanding of the relation soil arthropod-vegetation development in these ecosystems.

GPS-tracking and Accelerometry as tools to remotely detect and monitor the breeding of two declining steppe birds

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The Iberian Peninsula represents a stronghold for European steppe birds, such as the black-bellied (*Pterocles orientalis*) and the pin-tailed sandgrouse (*Pterocles alchata*), whose populations have been declining mainly due to land-use changes and agriculture intensification. Although there has been some research into understanding the breeding ecology of both species, information of their breeding success and reasons behind failures is still constrained, but of importance to inform on conservation actions. This limitation primarily arises from the difficulties in locating nests or chicks. With this work, we developed a framework, based on the combination of GPS-tracking data and sensor data (Overall Dynamic Body Acceleration; ODBA) and validated with field visits, to remotely detect and monitor nesting attempts of both species, characterising their breeding performance and the main factors influencing it.

Through the analysis of remote tracking data, from May to September 2021 and 2022, we were able to identify 38 black-bellied and 45 pin-tailed sandgrouse breeding attempts (16 tagged black-bellied and 18 tagged pin-tailed sandgrouse), performing subsequent visits to nests and families without jeopardising nesting success. Despite the extensive breeding season and frequent replacement clutches, we observed low reproductive success and very low productivity, highlighting the urgent need for effective conservation measures.

A comparison of monitoring methods to improve abundance estimation of the endangered Pin-tailed sandgrouse (*Pterocles alchata*)

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Abundance is an essential parameter to monitor population trends, assess viability, and determine the conservation status of endangered species. The low densities and sometimes elusive behaviour presented by threatened species make abundance estimation challenging, calling for more research on cost-efficient methods that provide robust abundance estimates. Here, we estimate abundance of the endangered Pin-tailed sandgrouse (*Pterocles alchata*) in two Special Protection Areas of the Lleida Plain (north-eastern Spain) in the year 2022. We compared one genetic Capture-Recapture (CR) and two Hierarchical Distance Sampling (HDS) monitoring approaches; both are robust sampling and modelling frameworks that allow accounting for imperfect detection. CR using molecular individual identification presented the most precise abundance estimates ($N = 104$, 95% BCI = 83-135), and allowed estimating the sex ratio. The HDS approach that used the general survey design for monitoring farmland birds in the study area allowed estimating abundance in 2022 only when integrating detection data from previous years, at a low precision ($N = 84.7$; 85% BCI = 17–157). The HDS approach that mimicks the sampling design of the Pin-tailed sandgrouse national monitoring program resulted in a low number of detections in the year 2022, which hampered abundance estimation, even when informing parameters with data from other regions. A high success rate in the molecular identification of individuals makes CR promising for estimating single-year abundances of this and other scarce steppe bird species.