19th International Conference on Environmental Science and Technology

CEST 2025

Kos, Greece, 3 to 6 September 2025

COMPAS: Pyric herbivory and precision livestock farming as a tool for landscape management

VÁZQUEZ MIRAMONTES D., SANTIAGO-FREIJANES J.J., RIGUEIRO-RODRÍGUEZ A., FERREIRO-DOMINGUEZ N., MOSQUERA-LOSADA M.R.

Department of Crop Production and Engineering Projects, High Polytechnic School of Engineering, University of Santiago de Compostela (USC), Lugo, Spain.

*corresponding author: María Rosa Mosquera Losada
e-mail: mrosa.mosquera.losada@usc.es

Abstract Pyric herbivory (PH) combines prescribed burning and targeted grazing to reduce wildfire risk and restore ecosystems by mimicking natural disturbances. Targeted grazing uses livestock strategically to manage vegetation, requiring knowledge of plant growth, animal behavior, and ecosystem dynamics. The COMPÁS project in Spain promotes this approach, integrating prescribed burns with environmental grazing to guide livestock to key areas. This reduces fuel loads and supports ecosystem recovery. The project uses advanced tools—satellite imagery, drones, GPS collars, and virtual fences—to monitor and optimize PH practices. It also aims to develop new regulatory frameworks to support implementation. This article presents results from a pilot in Galicia, focusing on animal behavior data and vegetation monitoring after prescribed burns

Keywords: Prescribed burns, extensive farming, animal behaviour, GPS collars, virtual fencing.

Introduction

Landscape management is essential to reduce wildfire risk. Traditional fire suppression has proven inadequate, as it overlooks root causes like biomass buildup from rural abandonment and the decline of traditional land-use practices (Moya et al., 2021).

Prescribed burning is now used to reduce fuel loads while preserving ecosystem functions (Casals et al., 2016), with minimal soil impact due to its low intensity and short duration (Moya et al., 2021).

Pyric Herbivory (PH), which combines prescribed burning with targeted grazing, offers a nature-based solution to manage vegetation and restore ecosystems (Fuhlendorf et al., 2004). This method replicates natural disturbance regimes and supports biodiversity, carbon storage, and rural revitalization (Fuhlendorf et al., 2010). PH depends on uniform grazing behavior to prevent shrub encroachment and maintain productive, diverse grasslands (Múgica et al., 2021). To support this, precision livestock farming is key, as traditional grazing models are outdated Technologies like GPS collars and virtual fences enable adaptive livestock control and resource synchronization (Asmare, 2022).

Objective

This study aims to assess the impact and feasibility of using GPS devices to manage environmental grazing, focusing on advancements in pastoral management and animal behaviour monitoring in targeted grazing systems.

Methodology

2.1. Study area

The study was conducted in a 12-hectare plot in Robledo de Son (Ancares Lucenses Biosphere Reserve of Galicia, NW Spain), with elevations between 600 and 800 meters and slopes of 5–15%. The area is enclosed with a simple electrified wire fence, allowing livestock free access to all available vegetation.

2.2 Experimental Design

After two prescribed burns the objective is to analyze differentiated grazing between the burned grassland area and the shrub regrowth area (Figure 1, left). Vegetation development in the plot shows noticeable differences, particularly the increased abundance of ferns following the burn (Figure 1, right).

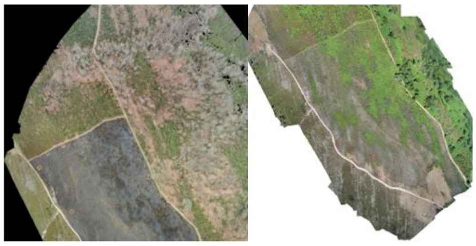

Figure 1. Plots in Robledo do Son, after the burn (left) on March 23, 2023, and four months later following vegetation recovery on July 27, 2023 (right).

Three *Digitanimal GPS* collars were used to evaluate their effectiveness in monitoring targeted grazing on a herd of *Rubia Galega* breed. Key metrics included location accuracy, distance travelled, activity levels, and grazing patterns every 30 minutes. The first entry of the herd took place on August 17th, 2023. Livestock density will vary depending on the time of year and vegetation development.

The GPS collar data will be exported to Excel and used to create heat maps to visualize behavioural patterns related to the animals' preference for specific vegetation types present in the plot (shrub or herbaceous species).

The results were summarized and organized by season to evaluate the animals' geolocation based on the type of existing vegetation (herbaceous pasture and post-burn regrowth areas) and climatic variations (Figure 2) with five patterns.

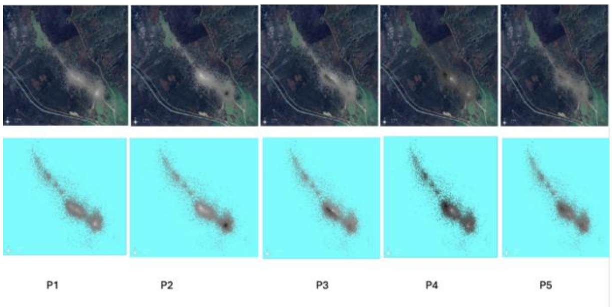

Figure 2. Point density maps over orthophotos generated from 10 months of GPS data (August 17, 2023 to June 28, 2024).

At the time of presenting this communication, the virtual fencing system had not yet been implemented. A preliminary study was conducted to select the most suitable technology for the area and the specific conditions of the study, concluding that the best option—due to connectivity—is **PAPPSTOR**, the only system on the market with **LoRaWAN** connectivity.

Results and discussion

The findings of this study highlight the critical role of strategic resource points—such as water and feed supplementation—in shaping livestock spatial behavior. The concentration of activity around these areas aligns with previous research showing that the distribution of essential resources directly influences grazing and movement patterns (Provenza & Villalba, 2006). These points act as attractors, limiting grazing dispersion and altering landscape impact.

Livestock tend to avoid distant areas to reduce energy expenditure, as shown by Bailey et al. (1998), who demonstrated that resource accessibility defines animals' range of movement. This spatial concentration can lead to localized overuse, increasing risks of soil compaction and vegetation degradation (Taylor, 2006). Therefore, a well-planned spatial distribution of water and feed points is a strategic tool for sustainable grazing management (Villalba et al., 2006).

Adaptive management strategies, such as targeted grazing, can help mitigate negative effects and promote more balanced grazing patterns. As Fernández and Navarro (2021) suggest, monitoring technologies—like the GPS collars used in this study—are essential for designing management systems that reduce environmental impacts and support ecosystem recovery.

Conclusion

We can conclude that GPS monitoring technologies can improve grazing management and support sustainable livestock systems. Strategic placement of water and feed points helps balance grazing pressure and protect fragile areas. Combining traditional practices with modern monitoring tools offers an effective approach to reduce environmental impact and enhance pasture sustainability.

References

Asmare, B. (2022). A review of sensor technologies applicable for domestic livestock production and health management. Advances in Agriculture, 2022, Article ID 1599190.

Bailey, D. W., Gross, J. E., Laca, E. A., et al. (1996). Mechanisms that result in large herbivore grazing distribution patterns. *Journal of Range Management*, 49(5), 386–400.

Casals, P., Valor, T., Besalú, A., & Molina-Terrén, D. (2016). Understory fuel load and structure eight to nine years after prescribed burning in Mediterranean pine forests. *Forest Ecology and Management*, 362, 156–168.

Fernández, F., & Navarro, J. A. (2021). The role of adaptive grazing management in fire-prone Mediterranean ecosystems. *Ecological Applications*, 31(7), e02389.

Fuhlendorf, S. D., & Engle, D. M. (2004). Application of the fire–grazing interaction to restore a shifting mosaic on tallgrass prairie. *Journal of Applied Ecology*, 41, 604–614.

Fuhlendorf, S. D., Townsend II, D. E., Elmore, R. D., & Engle, D. M. (2010). Pyric-herbivory to promote rangeland heterogeneity: Evidence from small mammal communities. *Rangeland Ecology & Management*, 63, 670–678.

Moya, D., Fonturbel, M. T., Lucas-Borja, M. E., Peña, E., Alfaro-Sánchez, R., Plaza-Álvarez, P. A., González-Romscero, J., & De las Heras, J. (2021). Burning season and vegetation coverage influenced the community-level physiological profile of Mediterranean mixed-Mesogean pine forest soils. *Journal of Environmental Management*, 277, 111405.

Múgica, L., Canals, R. M., San Emeterio, L., & Peralta, J. (2021). Decoupling of traditional burnings and grazing regimes alters plant diversity and dominant species competition in high mountain grasslands. *Science of the Total Environment*, 639, 175–185.

Provenza, F. D., & Villalba, J. J. (2006). Foraging in domestic herbivores: Linking the internal and external milieu. *Small Ruminant Research*, 61(2–3), 204–214.

Taylor, C. A. (2006). Targeted grazing to manage invasive plant species. *Rangelands*, 28(5), 3–7

Acknowledgments

COMPAS is supported by the Biodiversity Foundation of the Ministry for the Ecological Transition and the Demographic Challenge (MITECO) within the framework of the Recovery, Transformation and Resilience Plan (PRTR), funded by the European Union – NextGenerationEU.