

Short Communication

Remote sensing applications for monitoring habitat fragmentation

Makar Fang*

Department of Environment, Jiangxi Normal University, Nanchang 330022, China

**Corresponding author E-mail: markarfang@es.cn*

Received: 03 May, 2025, Manuscript No: UJE-25-170780, **Editor assigned:** 05 May, 2025, PreQC No: P-170780, **Reviewed:** 16 May, 2025, QC No: Q-170780, **Revised:** 23 May, 2025, Manuscript No: R-170780, **Published:** 31 May, 2025

Habitat fragmentation represents one of the most pervasive threats to biodiversity, ecosystem stability, and global environmental health. Driven primarily by human activities such as deforestation, urban expansion, agriculture, mining, and infrastructure development, fragmentation breaks large, contiguous habitats into smaller, isolated patches, thereby disrupting species interactions, reducing genetic diversity, and altering ecosystem functions. Monitoring habitat fragmentation is essential for biodiversity conservation and sustainable land management, yet conventional ground-based surveys are often limited in scale, accessibility, and temporal coverage. Remote sensing technologies, encompassing satellite imagery, aerial photography, LiDAR, and unmanned aerial vehicles (UAVs), have revolutionized the ability to assess fragmentation across spatial and temporal scales. By integrating spectral, spatial, and temporal data, remote sensing enables the detection of land-cover change, the mapping of habitat patches, the assessment of edge effects, and the evaluation of connectivity. This explores the role of remote sensing in monitoring habitat fragmentation, highlighting its methodologies, applications, case studies, and integration with Geographic Information Systems (GIS) and landscape ecology metrics. It also examines challenges such as spatial resolution, data accessibility, and interpretation complexities, while emphasizing the potential of emerging technologies like hyperspectral sensors, machine learning, and cloud-based platforms.

Keywords: Remote sensing, Habitat fragmentation, Biodiversity conservation, GIS, Land-use change, Forest monitoring, Landscape ecology, UAVs, LiDAR, Ecological connectivity.

Introduction

Remote sensing provides a powerful suite of tools for detecting and analyzing habitat fragmentation. Satellite imagery forms the backbone of these applications, offering long-term and wide-scale observations. Programs such as Landsat, Sentinel, and MODIS have enabled the continuous monitoring of land cover over decades, providing insights into how forests, wetlands, grasslands, and coastal ecosystems are changing. With spatial resolutions ranging from 10–30 meters for Sentinel and Landsat to sub-meter resolutions available from commercial satellites like WorldView and QuickBird, remote sensing allows researchers to capture both broad-scale trends and fine-scale habitat features. Multi-temporal analysis is particularly valuable, enabling the detection of gradual fragmentation processes or sudden events like clear-cutting, fires, or urban sprawl. For example, in the Amazon rainforest, long-term Landsat data has been used to track progressive fragmentation resulting from road construction, logging, and agriculture, highlighting how small clearings expand into larger patches of degraded forest (Liu X, et al. 2022).

Description

The integration of remote sensing with Geographic Information Systems (GIS) and landscape ecology metrics enhances the quantification of fragmentation. Metrics such as patch size, shape complexity, edge-to-area ratio, and nearest-neighbor distance can be derived from remotely sensed maps to assess the degree of fragmentation and habitat connectivity. These metrics inform conservation planners about critical thresholds below which species populations may collapse. For example, GIS-based fragmentation indices applied to African savannas have shown that increasing patch isolation reduces elephant migration routes, while in North American forests, GIS analyses reveal how urban sprawl fragments bird habitats. Remote sensing thus serves not only as a monitoring tool but also as a foundation for spatially explicit conservation strategies. Applications of remote sensing in fragmentation studies span diverse ecosystems. In tropical forests, deforestation and fragmentation are tracked using Landsat and MODIS imagery, with the Global Forest Change dataset providing annual updates on forest loss (Turvey ST, et al. 2007). In marine ecosystems, remote sensing of coral reefs and seagrass beds highlights how coastal development fragments critical habitats for fish and invertebrates. These applications demonstrate the versatility of remote sensing in addressing fragmentation across biomes.

Emerging technologies promise to further advance the monitoring of habitat fragmentation. Hyperspectral sensors, which capture hundreds of spectral bands, enable the detection of subtle changes in vegetation composition and health, providing early warnings of degradation before fragmentation becomes visible (Hunt TN, et al. 2020). Machine learning and artificial intelligence are increasingly applied to remote sensing data, automating classification and improving the accuracy of land-cover maps. Cloud computing platforms such as Google Earth Engine allow researchers to analyze massive datasets, perform time-series analysis, and generate fragmentation indices at unprecedented scales. These innovations reduce barriers to entry, enabling even resource-limited organizations to leverage remote sensing for conservation.

Despite its strengths, remote sensing also faces challenges in monitoring fragmentation. Spatial and temporal resolution trade-offs remain a concern, as high-resolution imagery is costly and often limited in temporal coverage, while free datasets like Landsat provide longer time series at lower resolution (Fu H, et al. 2021). Cloud cover poses a persistent obstacle in tropical regions, although radar sensors partially address this issue. Data interpretation can be complex, requiring careful calibration and validation with field observations to avoid misclassification. Socioeconomic and political constraints also influence the use of remote sensing, as conservation decisions depend not only on ecological data but also on governance, land tenure, and community participation. Addressing these limitations requires interdisciplinary collaboration, capacity-building, and open-access initiatives that democratize data use. The ecological significance of remote sensing-based fragmentation monitoring cannot be overstated. By identifying priority areas for conservation, tracking the effectiveness of protected areas, and detecting emerging threats, remote sensing informs proactive management (Butler JD, et al. 2020).

Conclusion

Habitat fragmentation poses a profound challenge to biodiversity conservation and ecosystem sustainability, with far-reaching consequences for ecological integrity and human well-being. Remote sensing has transformed the monitoring and analysis of fragmentation, offering scalable, repeatable, and multi-dimensional insights that surpass the limitations of traditional field methods. Through satellite imagery, UAVs, LiDAR, GIS integration, and emerging technologies, remote sensing enables the mapping of habitat patches, assessment of connectivity, and evaluation of fragmentation impacts across diverse ecosystems. While challenges remain in resolution, interpretation, and governance, advances in hyperspectral sensors, machine learning, and cloud-based platforms hold immense potential for overcoming these barriers. The integration of remote sensing into conservation planning not only enhances ecological understanding but also empowers policymakers, communities, and scientists to design effective interventions against fragmentation. Ultimately, the application of remote sensing to monitor and mitigate habitat fragmentation is not merely a technological advancement but a crucial step toward safeguarding biodiversity and ensuring resilient ecosystems in the face of accelerating global change.

Acknowledgement

None.

Conflict of Interest

The authors declare no conflict of interest.

References

- Liu, X., Mei, Z., Zhang, J., Sun, J., Zhang, N., Guo, Y., Wang, D. (2022). Seasonal Yangtze finless porpoise (*Neophocaena asiaeorientalis asiaeorientalis*) movements in the Poyang Lake, China: Implications on flexible management for aquatic animals in fluctuating freshwater ecosystems. *Science of the Total Environment* 807 : 150782.
- Turvey, S. T., Pitman, R. L., Taylor, B. L., Barlow, J., Akamatsu, T., Barrett, L. A., Wang, D. (2007). First human-caused extinction of a cetacean species?. *Biology Letters* 3 : 537-540.
- Hunt, T. N., Allen, S. J., Bejder, L., Parra, G. J. (2020). Identifying priority habitat for conservation and management of Australian humpback dolphins within a marine protected area. *Scientific Reports* 10: 14366.
- Fu, H., Wang, C., Cui, G., She, W., Zhao, L. (2021). Ramie yield estimation based on UAV RGB images. *Sensors* 21: 669.
- Butler, J. D., Purkis, S. J., Yousif, R., Al-Shaikh, I., Warren, C. (2020). A high-resolution remotely sensed benthic habitat map of the Qatari coastal zone. *Marine Pollution Bulletin* 160: 111634.
-

Citation:

Fang, M., (2025). Remote sensing applications for monitoring habitat fragmentation. *Ukrainian Journal of Ecology*. 15:22-24.



This work is licensed under a Creative Commons Attribution 4.0 License
