

Introduction

- Nature restoration law identifies forest connectivity as one of its key indicators, which is significantly affected by forest management, therefore, research on forest landscape characteristics is crucial. Such studies help inform strategies for enhancing biodiversity, improving ecosystem services, and ensuring long-term forest resilience.
- It is often asserted that higher biodiversity arises through continuous ecological processes (succession and natural disturbances) exhibiting higher complexity than human-made landscapes. But is this always true, or can human-managed landscapes sometimes achieve comparable or even higher levels of biodiversity and complexity?

Aim: to compare landscape patterns in un-managed and managed forests by analyzing long-term (1969-2022) historical remote sensing data.

Material and Methods

- Five hemiboreal forest landscapes in Latvia, affected by the **stand-replacing windthrow in November 1969**, comprising both unmanaged and managed areas, were selected for a long-term analysis (1969-2022).
- Selected un-managed areas in Slitere Nature Reserve (SNR) and Ziedru Forest Nature Reserve (ZFNR) and managed sites (Masivs I, Masivs II, Masivs III) adjacent to these reserves were classified into land cover classes using the Iso-Cluster algorithm in ArcMap 10.5.

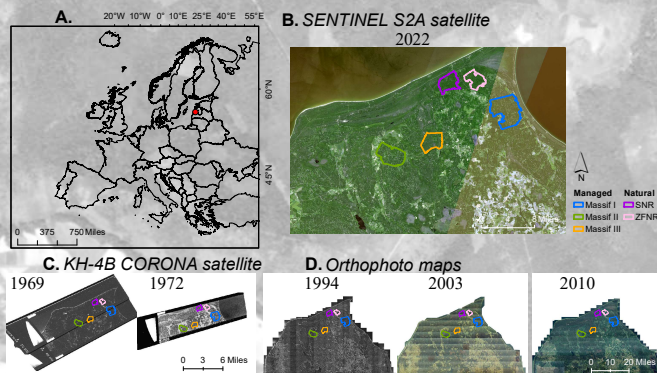


Figure 1. A. The Location of the study area within the European scale (red dot); Remote sensing imagery used in the study: B. Sentinel 2A satellite images (2022); C. Declassified Corona satellite images (1969, 1972); D. Aerial photography from the Latvian Geospatial Information Agency (1994, 2003, 2010).

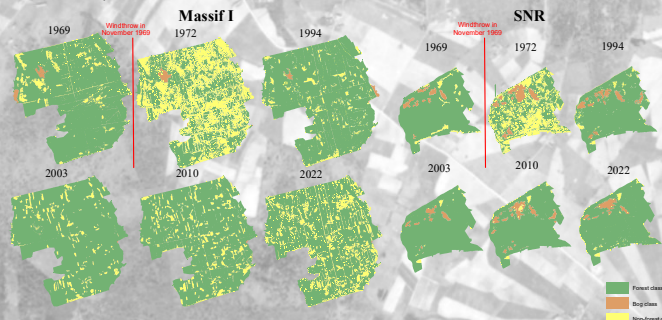


Figure 2. Iso cluster classification forest cover maps for the period from 1969 to 2022. Selected forest landscapes were classified in forest, non-forest, and bog areas based on image texture, spectral bands, and topographic maps, resulting in 30 land cover maps.



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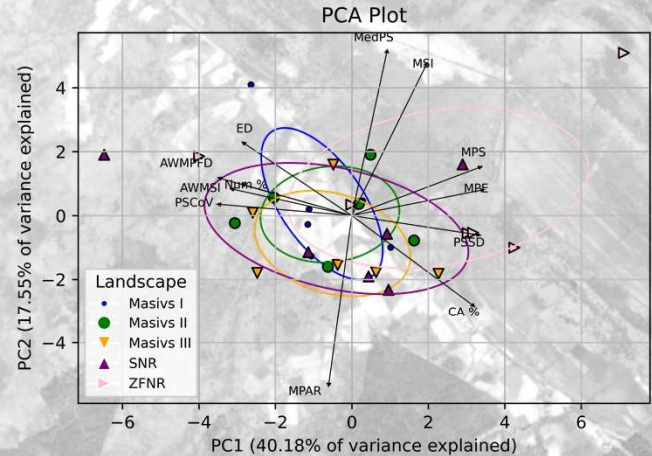


Figure 3. PCA ordination plot for landscape structure and composition metrics showing the first two axes of the PCA analysis. The centroids of the points belong to the forest class. Ellipses represent 95% confidence for forest massifs, and the eigenvalues and eigenvectors of the covariance matrix determined their size and shape.

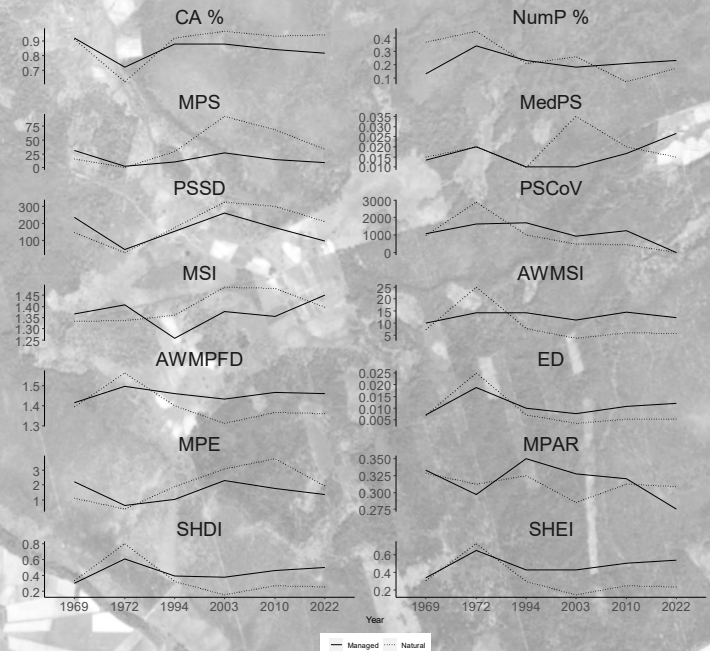


Figure 4. The dynamics of landscape metrics in the managed and natural (un-managed) landscapes. (Class area proportion (CA %), Number of Patches proportion (NumP %), Mean Patch Size (MPS, ha), Patch Size Coefficient of Variance (PSCoV, ha), Patch Size Standard Deviation (PSSD, ha), Mean Patch Edge (MPE, km), Median Patch Size (MedPS, ha), Edge density (ED, m/ha), Mean Shape Index (MSI), Average weighted mean shape index (AWMSI), Area-Weighted Mean Patch Fractal Dimension (AWMPFD), Mean Perimeter-Area Ratio (MPAR))

Results and conclusion

- The PC1 explained 40.7% of the variation, related to landscape fragmentation and patch heterogeneity metrics (AWMPFD, PSCoV, PSSD, MPE, MPS), while the PC2 explained 17.2% of the variation representing a gradient of complexity in landscape composition, configuration and connectivity (MedPS, MPAR, MSI, CA %, ED).
- Characterization of landscape composition and configuration suggested similarities between both un-managed and managed forest landscapes, based on the position of all variables and the confidence ellipses on the PCA ordinate axis.
- Larger size and more complex shape patches in one of two un-managed (MPS and MPE) landscapes illustrates some differences between un-managed and managed landscapes. Our results however, indicated that the variation among managed landscaped did not exceed the amplitude of the variation in un-managed landscape