

Examining how lichens, understorey plants, birds, and bats align at NEC Directive forest sites in Italy

Luisa Frati¹, Francesca Giorgolo¹, Luana Francesconi¹, Stefano Chelli², Marco Cervellini², Giandiego Campetella², Roberto Canullo², Paolo Colangelo³, Bruno De Cinti³, Flavia Sicuriello³, Giorgio Brunialti¹

1 TerraData srl environmetrics, Spin-off dell'Università di Siena; 2 School of Biosciences and Veterinary Medicine, University of Camerino; 3 CNR IRET, Istituto di Ricerca Ecosistemi Terrestri, Montelibretti, Roma.

INTRODUCTION

The recently completed LIFE MODERn (NEC) project tested new indicators related to the functional diversity of various groups of organisms. Its goal was to identify sensitive and effective indicators for forest ecosystem monitoring, and support their integration into routine methods used by Italian and European monitoring networks.



AIM

To assess whether the taxonomic groups monitored within the NEC Directive Network respond consistently and covary across different forest sites.

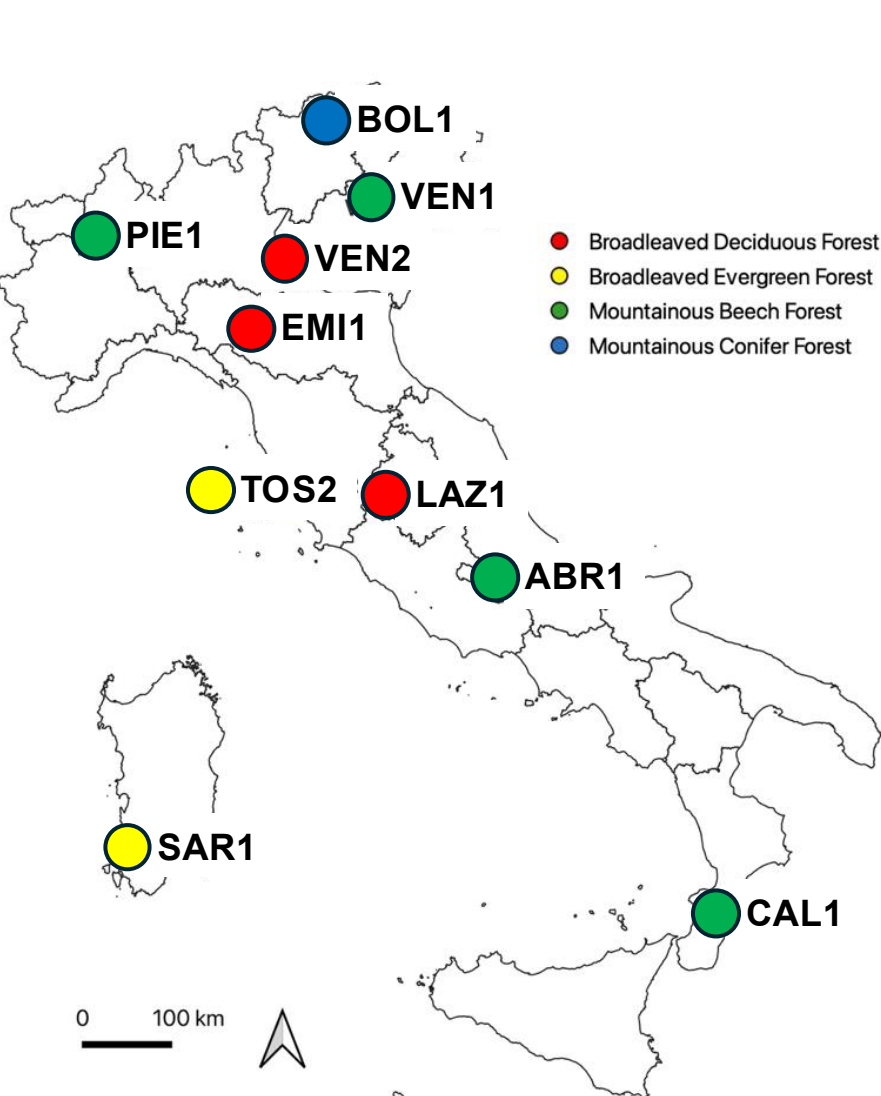
MATERIALS AND METHODS

The study considered the ten permanent forest sites of the Italian NEC Directive Network. In the spring and summer of 2023 and 2024, we surveyed the biodiversity of:

- Epiphytic lichens (ICP Forests method; LDV sampling grid)
- Bats and birds (passive acoustic monitoring recorders method)
- Understorey plants (ICP Forests method)

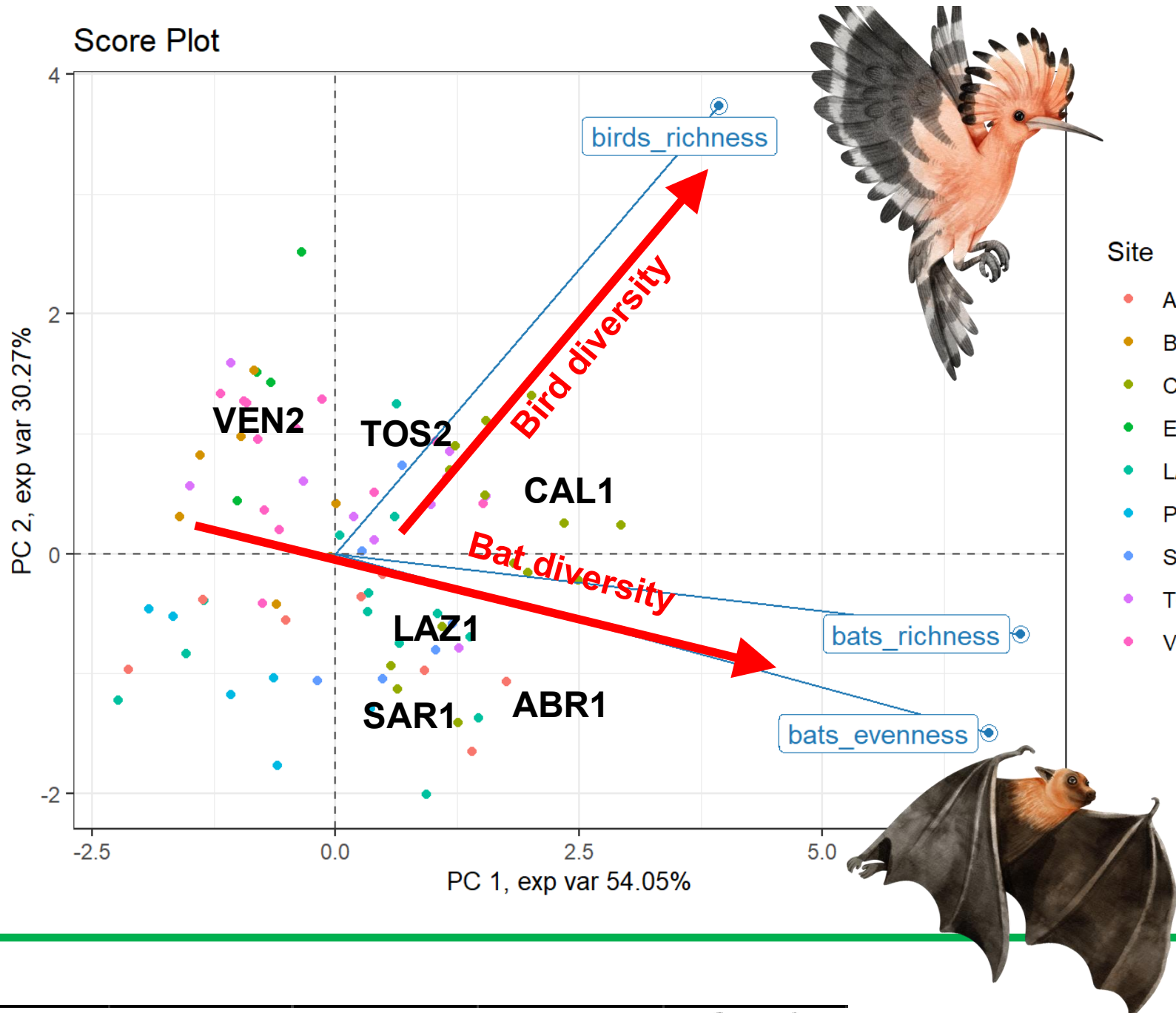
The Italian NEC Directive Network

10 Forest sites



- 4 Mountainous Beech Forests (MBF)**
Selva Piana (ABR1), Piano Limina (CAL1), Val Sessera (PIE1), Pian del Cansiglio (VEN1). Dominated by *Fagus sylvatica*. Elevations 1100-1500 m.
- 3 Broadleaved Deciduous Forests (BDF)**
Carrega (EMI1), Monte Rufeno (LAZ1), Bosco Fontana (VEN2). Elevations 60-690 m.
- 2 Broadleaved Evergreen Forests (BEF)**
Marganai (SAR1), Cala Violina (TOS2). Dominated by *Quercus ilex*. Elevations 30-700 m.
- 1 Mountainous Conifer Forest (MCF)**
Renon (BOL1). Dominated by *Picea abies* (1740 m).

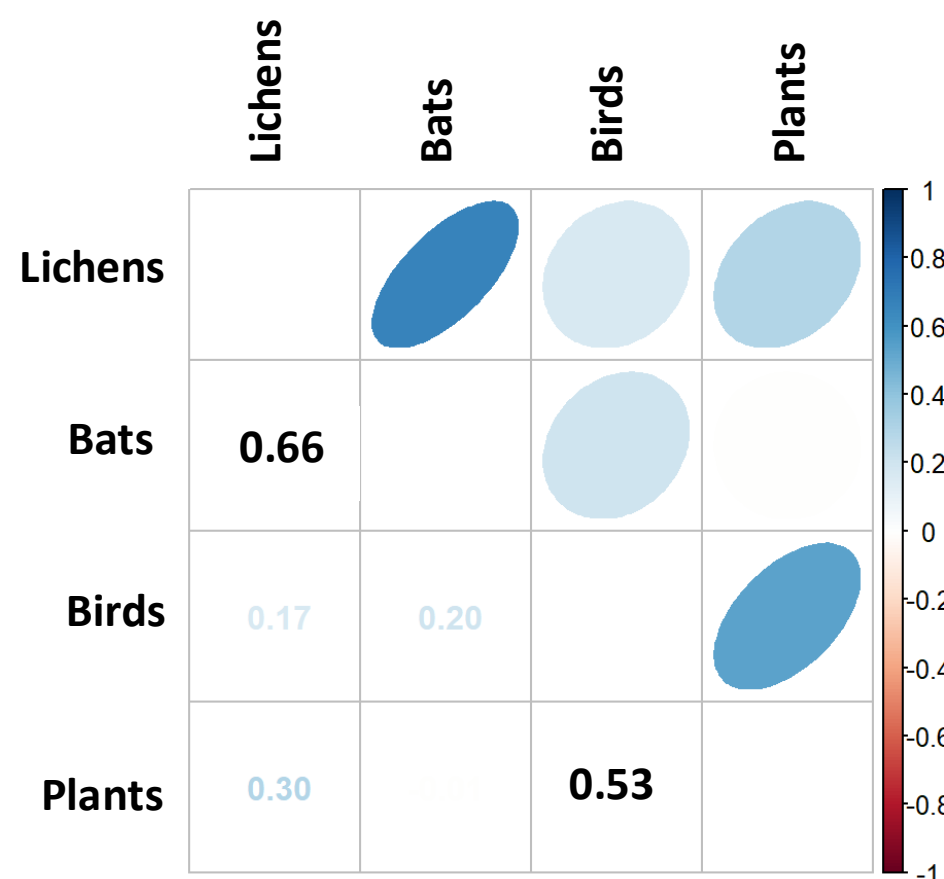
Relationship between bird and bat diversity



Bird species richness and bat richness and evenness are separated along PC2, showing opposite patterns.

CAL1, VEN2, and TOS2 have higher bird richness values, while bat diversity is higher at ABR1, CAL1, SAR1 and LAZ1.

Relationship between biodiversity groups: species richness

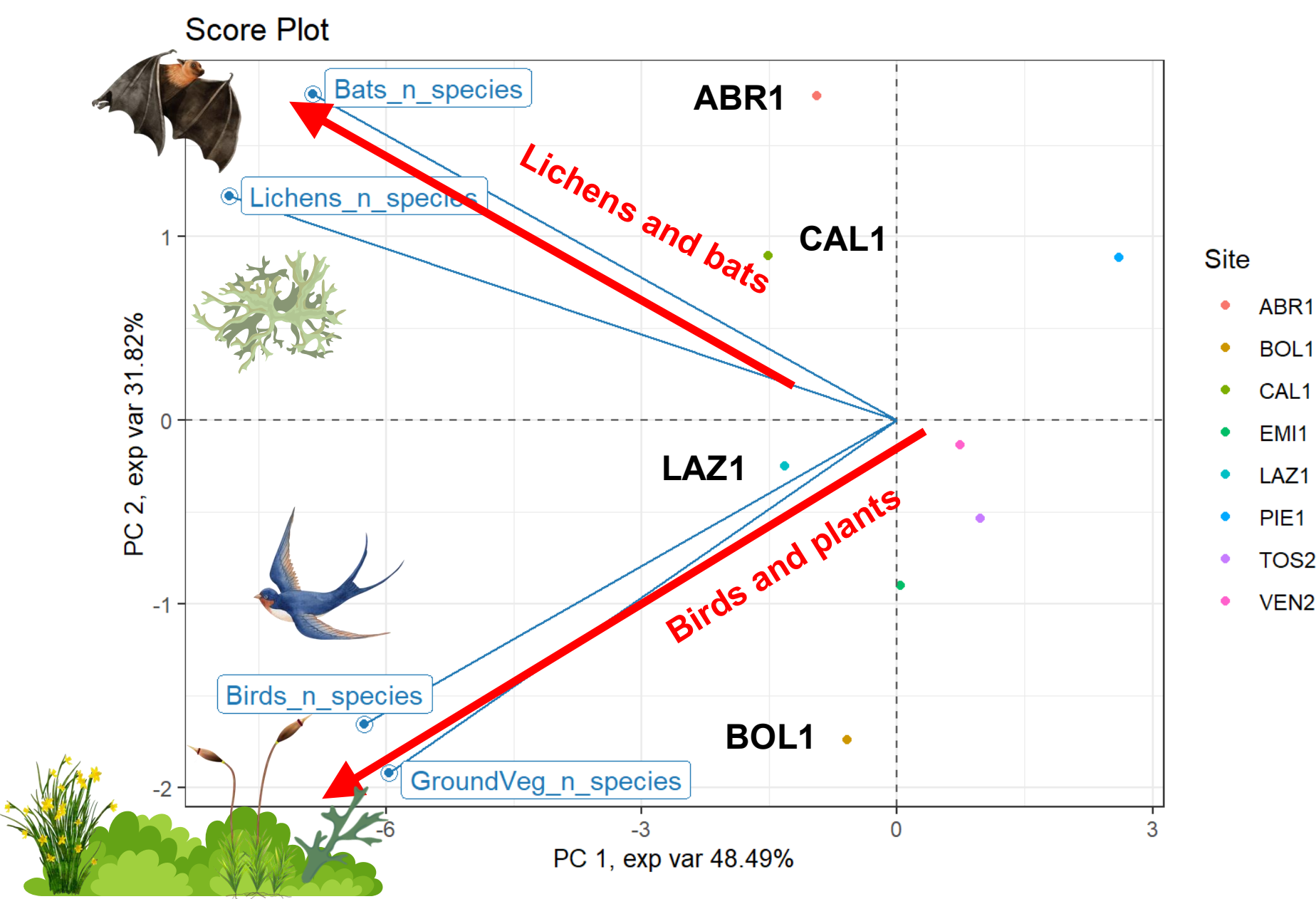


Positive correlation between lichen and bat diversity ($r=0.66$) and between birds and herbaceous plants ($r=0.53$)

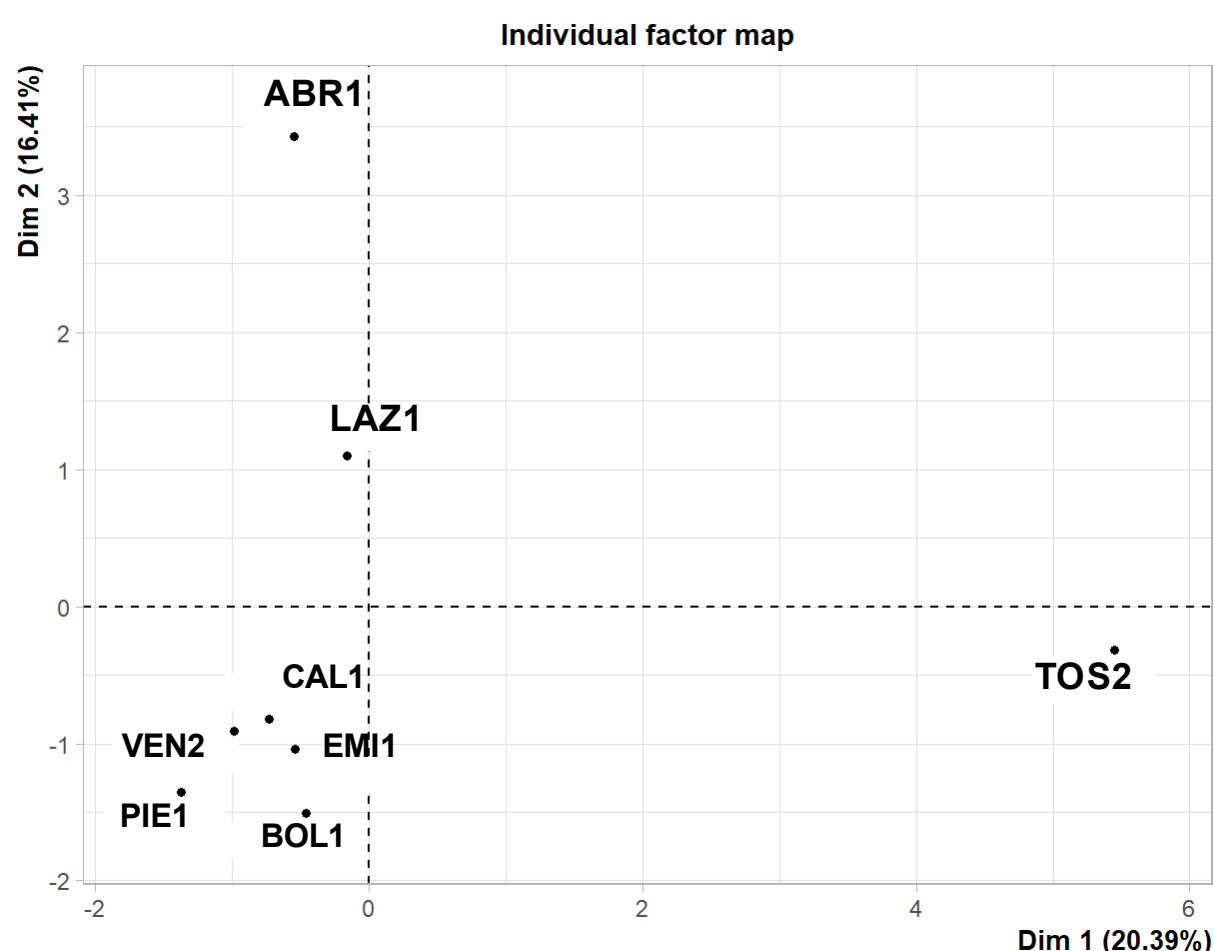
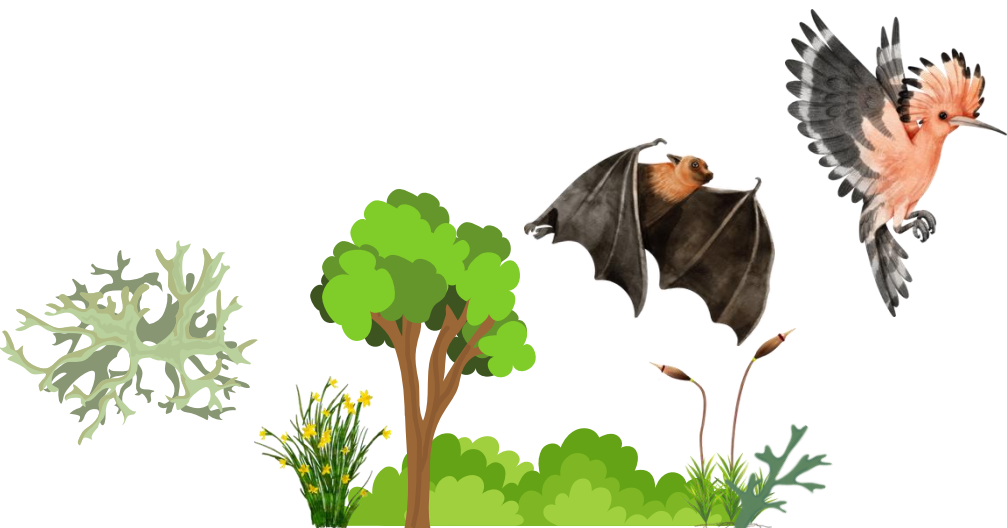
PCA RESULTS

Plant and bird diversity correlate with each other and align with negative PC2 values in relation to the Broadleaved Deciduous Forest of LAZ1 and the Mountainous Conifer Forest (BOL1).

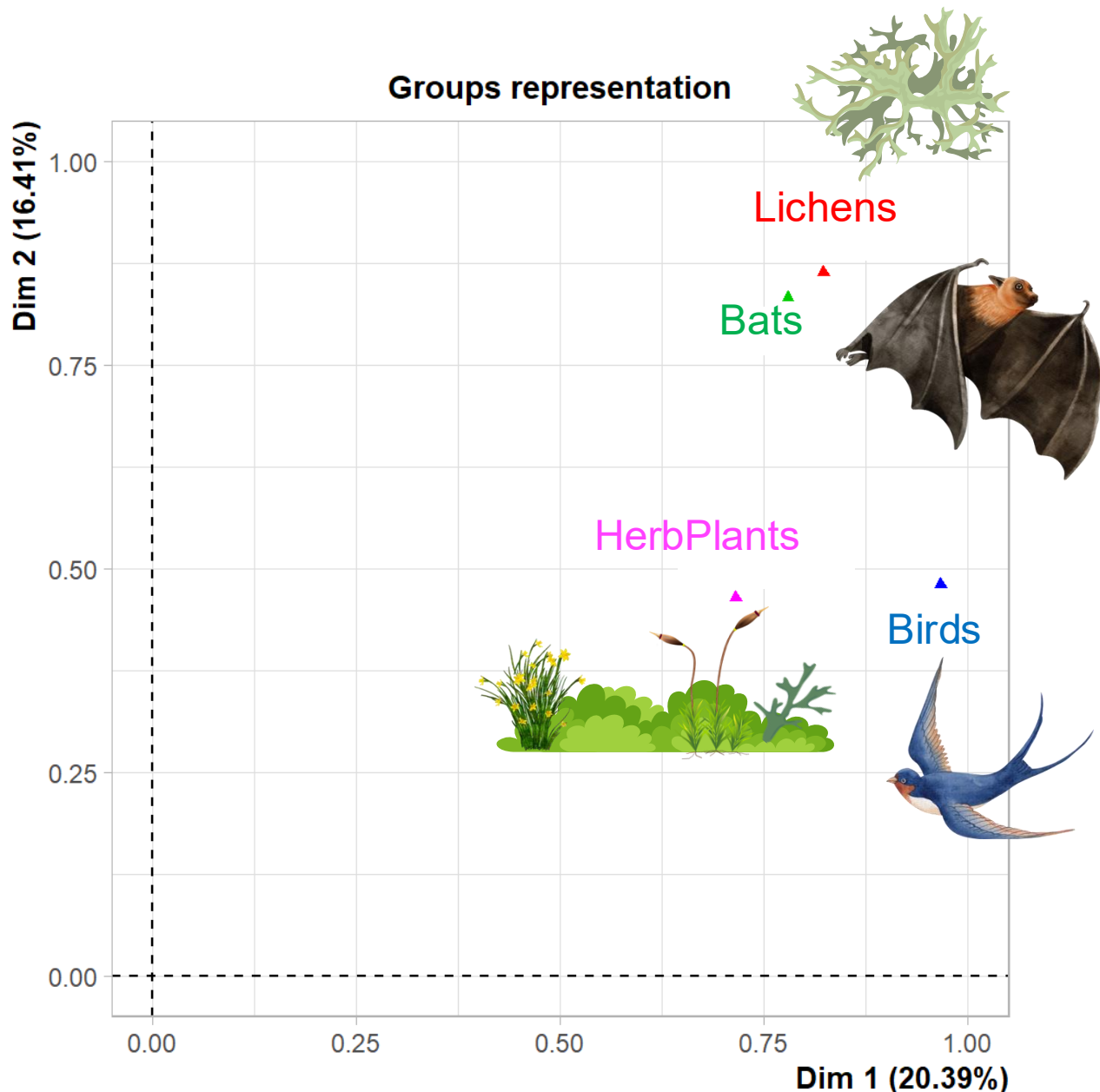
Lichen and bat diversity correlate with each other and with positive PC2 values, associated with the Mountainous Beech Forests of ABR1 and CAL1.



Relationship between biodiversity groups: species composition



Multiple Factor Analysis (MFA) confirms the results of the PCA



Lichen and bat communities are related to each other, as well as birds and herbaceous plants are related to each other.