Wildlife and Agroforestry
What is a Agroforestry system?

“Agroforestry is an integrated approach of using the interactive benefits from combining trees and shrubs with crops and/or livestock. It combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy and sustainable land-use systems.” (USDA - National Agroforestry Center)

- Only trees, shrubs and crops? A community? An ecosystem?
- Includes animals? Streams and lakes?
- Ecological processes like nutrient and energy cycling?
Composition, structure & function

**COMPOSITION**
- Genetic diversity
- Species abundance, richness and diversity
- Community diversity
- Habitat diversity

**FUNCTION**
- Energy Capture & Trophics
- Mineral and nutrient cycles
- Water movement
- Ecological succession
- Disturbance

**STRUCTURE**
- Vertical and horizontal
- Spatial heterogeneity and density
- Edge Effect
- Island effect and Fragmentation
- Logs and dead trees
Structure

**Vertical Structure**

- Dominant
- Co-dominant
- Intermediate
- Shrubs
- Ground Cover

**Horizontal Structure**

- Natural habitat
- Transformed habitat

**Spatial heterogeneity**

![Diagram showing vertical and horizontal structure with elements of natural and transformed habitats over time.](image-url)
Fragmentation

1
2
3
time

Structure
Habitat Fragmentation

Fragmentation change directly or indirectly the abundance of species and its distribution, affecting interactions between species.
Edge effect

Effect of the juxtaposition of contrasting environments on an ecosystem. Create mixed communities, containing features of both systems in contact.
Structure

Island effect

The isolation of forest fragments - Island biogeography theory (MacArthur & Wilson 1963).

Figure 1. Location of the Abrolhos National Marine Park showing the distribution of islands in the archipelago.

Figure 4. Relationship between the number of species and the size of the islands in the Abrolhos archipelago.
Characteristics:

- Perennial oak woodlands (cork oak & holm oak)
- Low tree density (less than 40% cover).
- Economic value: acorn for livestock feed, bark from the cork oak, wild mushrooms, charcoal, and firewood.
- Understory: annual grasslands for grazing / cereals (wheat, barley, oats, rye).
- Different habitats and food available for wildlife.
Iberian Agroforestry system
“montado” / “dehesa”
Composition

1 - pica-pau-verde (*Picus viridis*) e fauna associada;
2 - pombo-torcaz (*Columba palumbus*);
3 - picanço-real (*Lanius excubitor*)
   e picanço-barreteiro (*Lanius senator*);
4 - pega-rabuda (*Pica pica*);
5 - águia-calçada (*Hieraaetus pennatus*);
6 - águia-de-asa-redonda (*Buteo buteo*);
7 - águia-real (*Aquila chysaetos*);
8 - cegonha-branca (*Ciconia ciconia*);
9 - milhano (*Milvus milvus*)
   e milhafre-preto (*Milvus migrans*);
10 - mocho-galego (*Athene noctua*);
11 - coruja-das-torres (*Tyto alba*);
12 - gralha-de-nuca-cinzenta (*Corvus monedula*);
13 - morcegos;
14 - geneta (*Genetta genetta*);
15 - lince (*Lynx pardinus*);
16 - coelho-bravo (*Oryctolagus cuniculus*).
AVES Y MAMIFEROS
(Tellería et al. 1992)

CULTIVOS

PASTIZALES

MATORRALES

DEHESAS

AVES NIDIFICANTES

AVES INVERNALES

MAMIFEROS (Conejo, Liebre, Zorro, Jabalí, Ciervo)

NUMERO DE ESPECIES (10-150 ha)
MARIPOSAS DIURNAS
(Viejo et al. 1989)

NUMERO DE ESPECIES (2-13 LOCALIDADES)
Composition

FANEROGAMAS
(Marañón 1991)

NUMERO DE ESPECIES (1000 m²)

BOSQUE TEMPLADO
CHAPARRAL
MAQUIS
MALLE-BREZAL
FYNBOS
BOSQUE MEDITERRANEO
DEHESA
MATORRAL MEDITERRANEO
BOSQUE TROPICAL

?
RIQUEZA DE ESPECIES DE AVES NIDIFICANTES EN DEHESAS
SEGÚN LA COBERTURA DE ARBÓLADO
(Pulido & Díaz, inédito)

NUMERO DE ESPECIES = 2.18 + 0.17 x COBERTURA
correlación parcial=0.542; %varianza=48.1; p=0.014
Foliage height diversity (FHD) vs. Bird diversity (Wilson, 1974)

Figure 3.1. Foliage height diversity (FHD) versus bird species diversity (BSD). * represent the study sites. (Reproduced from Willson 1974 [fig. 1], by permission of the Ecological Society of America)
Assessment of the vegetation structure influence on bird communities’ occurrence in Portuguese agroforestry systems
Objectives

• To study of the relationships between the vegetation vertical structure and the breeding bird (passerine) community composition.

• To identify physiognomic types of vegetation with faunistic importance, based on different measures, including vegetation vertical structure, percentage of vegetation cover types, and vegetation diversity measures.

• To develop a methodology to classify vegetation in order to understand the breeding bird composition and distribution.

• This approach for classifying habitat types allows a consistent development of wildlife management strategies in agroforestry systems.
Location

Area 1 - Setúbal

Area 2 - Évora
**Methods**

**Data collection**

- 4 transects - 2 in Évora (Santa Sofia and Guadalupe/Valverde) and 2 in Setúbal (Marco do Grilo and Lagoa do Golfo).
- The transects have a total length of 2 km, divided in 10 sections of 200 m each.

**Avian species:**

- Bird censuses were carried out between April and June. 6 visits in each transect. 24 censuses in total.
- Experienced field workers took note of all visual and auditive contacts.
• **Vegetation:**


- All plant species were registered. A percent cover for the 3 vertical layers was assessed (tree, shrub, and herbaceous layers).

**Data analysis**

Avian diversity and plant diversity values were obtained using the Shannon-Wiener diversity index (MAGURRAN, 1988).

\[
H' = - \sum_{i=1}^{s} p_i \ln p_i
\]

\[p_i = \frac{n_i}{N}\]

The relative abundance of each species, calculated as the proportion of individuals of a given species to the total number of individuals in the community.

\[s = \text{number of species (species richness)}\]

**Vertical structure of vegetation was measured using the Foliage Height Diversity** (ANDERSON & OHMART, 1986)
Vegetation

Avian communities

Avian diversity

Percentage cover of vegetation strata (vertical layers)

Vertical structure diversity and floristic diversity

Feeding and Nesting guilds

Linear regression

Vegetation attributes Vs. Avian richness and diversity

Relationships between physiognomic types and habitat guilds

Principal Component Analysis

Sections classification

Species classification

Physiognomic types

Methods
Vegetation

Avian communities

Avian diversity

Percentage cover of vegetation strata (vertical layers)

Vertical structure diversity and floristic diversity

Feeding and Nesting guilds

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Linear regression

Vegetation attributes Vs. Avian richness and diversity
Results

Absolute frequencies of passerine species - Évora

S = 39; n = 6
Results

Absolute frequencies of passerine species - Setúbal

S = 27; n = 6
### Principal Component Analysis - Santa Sofia (Évora)

*Pearson* correlation coefficient - 3 first PCA axes

<table>
<thead>
<tr>
<th>Variables</th>
<th>PC1</th>
<th>PC2</th>
<th>PC3</th>
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<tbody>
<tr>
<td>Foliage Height diversity</td>
<td>-0.2851</td>
<td>0.7461</td>
<td>0.4223</td>
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<td>Floristic diversity</td>
<td>0.4490</td>
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<td>Tree cover (%)</td>
<td>-0.2066</td>
<td>0.8158*</td>
<td>-0.0124</td>
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<tr>
<td>Shrub cover (%)</td>
<td>0.1874</td>
<td>0.9678**</td>
<td>-0.0008</td>
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<tr>
<td>Herbaceous cover (%)</td>
<td>-0.7929*</td>
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<tr>
<th></th>
<th>Eigenvalue</th>
<th>Variance explained (%)</th>
<th>Cumulative variance (%)</th>
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<td></td>
<td>12.96</td>
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<td>6.04</td>
<td>17.8</td>
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*p<0.05;  **p<0.01;  ***p<0.001
Principal Component Analysis - Santa Sofia (Évora)
Species ordination - PC1 and PC2

High structural diversity “Montado”

“Montado” with a shrubby understory

“Montado” with a herbaceous understory
# Principal Component Analysis - Marco do Grilo (Setúbal)

**Pearson correlation coefficient - 3 first PCA axes**

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<td>Tree cover (%)</td>
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<td>0.9456**</td>
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<td>Shrub cover (%)</td>
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<td>Herbaceous cover (%)</td>
<td>-0.5162</td>
<td>0.4973</td>
<td>-0.9876***</td>
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<tr>
<th>Variables</th>
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<tbody>
<tr>
<td>Eigenvalue</td>
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<td>Variance explained (%)</td>
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<td>Cumulative variance (%)</td>
<td>33.8</td>
<td>62.6</td>
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*p<0.05; **p<0.01; ***p<0.001
Principal Component Analysis - Marco do Grilo (Setúbal)
Species ordination - PC1 and PC3

Species ordination:
- PC1 and PC3

Tree cover:
- Dense Pineyard
- Sparse Pineyard/Open areas

Herbaceous cover:
- PC 3 (24.2%)
Agglomerative technique (UPGMA) of the dissimilarity values (Pearson coefficient) for avian communities

Évora transects

Physiognomic types

Herbaceous communities

Sparse “Montado” with herbaceous understory

Sparse “Montado” with a shrub/herbaceous mosaic

Different types of “Montado”

Legend: letters - transects, numbers - sections
Agglomerative technique (UPGMA) of the dissimilarity values (Pearson coefficient) for avian communities

Setúbal transects

Physiognomic types

Medium density Pineyard with a shrubby understory

Sparse Pineyard with a high density shrubby understory

High density Pineyard

Shrub communities

Legend: letters - transects, numbers - sections
Conclusions

*Relationships between avian communities and vegetation measures*

**Évora**

- The main feature that influences the passerines distribution seems to be the understory characteristics.

- The Classification Analysis confirmed the results obtained with the PCA, addressing the importance of the dominance/co-dominance of the shrub and herbaceous layers in the differentiation of the avian communities.

**Setúbal**

- The tree cover density is the variable that better explains the differentiation of the avian communities.
Conclusions

*Relationships between the vegetation attributes and the avian diversity*

 Didn’t exist a relationship between the vertical diversity of vegetation and the avian diversity in the studied agroforestry systems.

Évora

For the “Montado” system, a increase of the tree cover is associated to a increase in avian richness and diversity, possibly due to the existence of different habitat structures.