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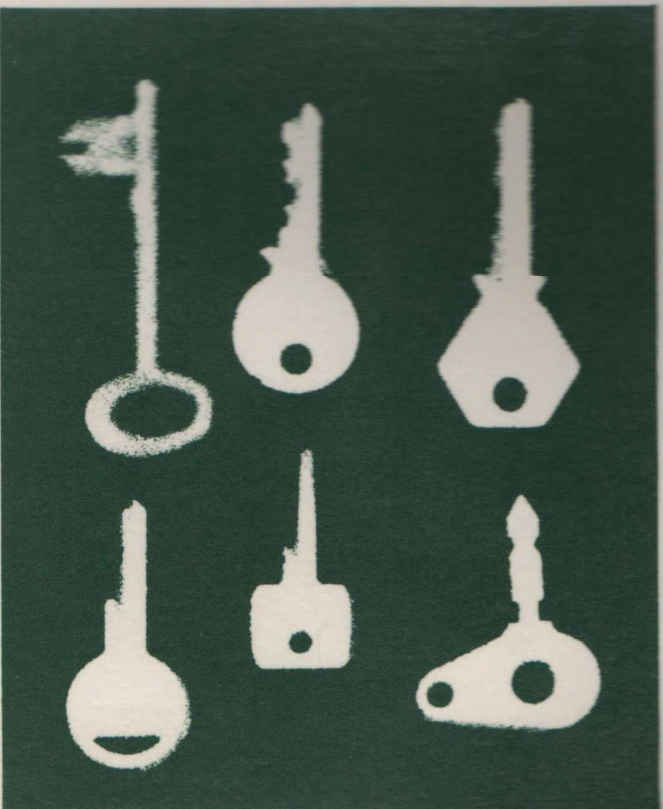
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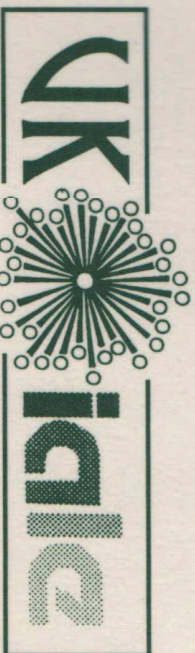
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# KEY CONCEPTS IN LANDSCAPE ECOLOGY

PROCEEDINGS OF THE 1998 EUROPEAN CONGRESS OF THE  
INTERNATIONAL ASSOCIATION FOR LANDSCAPE  
ECOLOGY



EDITED BY  
J.W. DOVER & R.G.H. BUNCE



effect of variability in management intensity for each cover type across the catchment. The simulation that assumed a 50% similarity of species between contrasting land covers is the most realistic model (Fig. 3) and revealed a significant but small rate of decline in species density of one species every 5.7 years during the 18 year period.

### Discussion

The model (for 50% species similarity) suggested a loss of one species every 5.7 years from enclosed land in recent years. However, longer term data suggest this rate of loss could be the tail of an exponential decline in species since the 1950s, equivalent to a minimum loss of 50% of species between 1952-1982 (Potts, 1992). This was due to the development of rapid, mechanised farming methods, accompanied by increased field sizes and the widespread use of synthetic fertilizers and broad spectrum pesticides. However, the calculations do not take account of the influence on the botanical and arthropod diversity in managed enclosures, of the diversity and proximity of remnant, semi-natural biotopes in the River Earn catchment. Further research in the current project will investigate this and other influences, such as the effect on plant and animal species in enclosures of the degree of synchrony of management inputs, as related to crop diversity. The variability in species densities indicated by the model suggests there is scope for farmers to modify practices so as to encourage plants and small animals back into managed land from the precarious situation of small, vulnerable populations in peripheral remnants of habitat.

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### Analysis of the ecological evolution of an area in the Setubal Peninsula (Apositica) caused by changes in land use patterns

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### Abstract

After conducting an inventory and characterisation of the existing elements belonging to the ecological structure at a regional level, located in a particular area at three defined moments in time, a subsequent analysis of the modification of biological structures of the area was undertaken.

This analysis involved the application of different diagnostic indices in order to evaluate the causal relationships between modifications in land use and the environmental modifications observed.

### Methods

The aim of the present study was to analyse the evolution of land use patterns and environmental functions in Apositica, an sub-regional area in the Setubal Peninsula.

The study zone is located in the West area of the Setubal Peninsula and was chosen for study because it serves as a dynamic model of land use modification, while simultaneously playing an important role in connecting habitats of great ecological value.

The year 1966 was considered the starting point (base year) for the modifications, as that year marks the opening of a bridge over the Tagus River and the beginning of a direct traffic connection between Lisbon and the Setubal Peninsula.

A structural characterisation and analysis of the main elements belonging to the overall ecological structure was completed for each year identified in the study in order to analyse the modification of the biological structures in the study area. The applicability of the different functional and structural indices developed by several authors, were tested [e.g., Short (1988), Shannon and Weaver (1962), Romme *et al.* (1982)].

A diachronic analysis of the index values obtained provided the data necessary to characterise the environmental impacts caused by the modifications in land use patterns. This analysis will make possible the determination of the most accurate methods of evaluating environmental impacts for the study area and facilitate the analysis of the causal relationships existing between modifications in land use and the environmental changes observed.

### Objectives

The testing of different methodologies normally used to characterise ecological structure at a regional scale in an area of sub-regional dimensions.

The testing of the applicability of the different methods of analysis of effects originated by losses in ecological structures (cumulative losses in ecosystems).

The conception of conclusions regarding causal relationships between land use modifications and the environmental changes observed.

### Results

Three indices were tested as measures to describe different properties of the landscape, the habitat layers index (Short, 1988), the diversity index originated in information theory (Shannon and Weaver, 1962) and the landscape contrast index (Romme *et al.*, 1982).

Table 1 Indices of Landscape Analysis

Index	Parameter	Numerical expression	Description
Diversity Index (Shannon and Weaver, 1962)	habitat diversity	$H' = -\sum p_i \log p_i$	Measure of species and community diversity. $p_i$ represents a proportion of the total habitat area covered by the category $i$ of the canopy.
Habitat Layers Index (Short, 1988)	vertical habitat structure	$HLI = \frac{x \cdot \sum A_i}{(6) \cdot (\sum A_i)}$	The HLI is computed by comparing the number and area of different habitat layers present on a study area to the maximum number and area of habitat layers that could occur for that study area.
Landscape Contrast Index (Romme <i>et al.</i> , 1982)	Discontinuity between community types	$LC = \sum_{i=1}^n \sum_{j=1}^n D_{ij} L_{ij}$	Measures the degree of compositional discontinuity across vegetation type boundaries in a landscape, was determined with a modified form of Romme's patchiness index.

The result of the application of the habitat layers index (Short, 1988) indicates that this index could be useful to analyse the changes in biotope quality. The agricultural land use units abandoned, are well identified by a decrease of the habitat layers index.

To study the structural diversity of the landscape was applied a diversity index originated in information theory (Shannon and Weaver, 1962). That index gives information about the degree of heterogeneity of the land forms and vegetation cover belonging to a land use unit.

The mapping of the Shannon index could be important in order to analyse the natural and semi-natural structures. For artificial structures the results are not so correct, and was difficult to establish a relation between the land use quality and its structure.

The mapping of the landscape contrast index could be useful to identify potential corridors for species flows across the landscape.

Table 2 Habitat layers used by some target species in the Setúbal Peninsula (Rosário, 1996)  
 (Feeding habitat - +; Reproduction habitat - \*)

Species	A	Cn	Lg	SCn	SL	Sf	Sbsl	W/Sf	W/Bd	W/Ar.	Ind.
<i>SALAMANDRIDA</i>											
<i>Triturus marmoratus</i>									++		+
<i>EMTIDAE</i>											
<i>Mauremys leprosa</i>								*	++	+	+
<i>LACERTIDAE</i>											
<i>Acanthodactylus erythrurus</i>									++		
<i>Podarcis hispanica</i>									+	*	
<i>ARDEIDAE</i>											
<i>Ardea purpurea</i>									+	*	+
<i>kobrychus minutus</i>									++		+
<i>CICONIIDAE</i>											
<i>Ciconia ciconia</i>									+	*	+
<i>PHOENICOPTERIDAE</i>											
<i>Phoenicopus ruber</i>									*		+
<i>ACCIPTRIDAE</i>											
<i>Circus pygargus</i>									++		
<i>Hieraeetus fasciatus</i>									+	*	+
<i>Mihus migrans</i>									+	*	+
<i>FALCONIDAE</i>											
<i>Falco naumanni</i>									+	*	+
<i>Falco peregrinus</i>									+	*	+
<i>RECURVOROSTRIDAE</i>											
<i>Himantopus himantopus</i>									++		+

<i>Recurvirostra avosetta</i>	+	+	+	+
<b>STERNIDAE</b>				
<i>Chlidonias hybrida</i>	*	*	+	+
<i>Sierra sandvicensis</i>	*	*	+	+
<b>ALAUDIDAE</b>				
<i>Calandrella brachydactyla</i>	+	+	+	+
<i>Lullula arborea</i>	+	+	+	+
<b>RHINOLOPHIDAE</b>				
<i>Rhinolophus hipposideros</i>	+	+	+	+
<i>Rhinolophus euryale</i>	+	+	+	+
<b>VESPERTILIONIDAE</b>				
<i>Episcopus serotinus</i>	+	*	*	*
<b>MINIOPTERIDAE</b>				
<i>Miniopterus schreibersii</i>	+	*	*	*
<b>ARVICOLIDAE</b>				
<i>Microtus cabreriae</i>	+	*	*	*
<b>MUSTELIDAE</b>				
<i>Lutra lutra</i>	+	+	+	+

A - Aerial Cn - Canopy Lg - Log SCh - Sub Canopy SISF - Soil Surface  
 SbsI - Sub Soil W/SF - Water Surface W/BD - Water Body W/A - Wetlands Ind. - No difference

## Discussion

The methodologies available to characterise ecological structure and function are not sufficient. Mainly because the study of functional aspects of landscape had a very recent evolution. The main limitation of the methodologies of ecological evaluation available is due to the use of measuring units not adequate to the study of functional properties, like ecological relations.

The parameters usually measured by the methodologies available only represent a small number of characteristics of the systems. This approach however more accessible and convenient, determines that the ecological systems are simplified in such a way that the most important properties became unclear.

## Conclusions

On the basis of above mentioned considerations it's necessary to develop models for the ecological characterisation of land use structure with application in regional planning process, namely a methodology to analyse effects originated by losses in ecological structures, in way to identify indices of ecological evaluation.

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