

THE THREAT OF CRYPTIC HABITAT LOSSES FOR BIRDS IN A TRADITIONAL LANDSCAPE IN CENTRAL GREECE

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Abstract:

The Balkan in general and Greece in particular host a varied ornithofauna, both migratory and resident species. The bird species richness matches a wide range of available biotopes, often small scaled in a complex landscape. Though the Greek landscape is shaped by human intervention at a millennial scale, recent years have accelerated landscape change with a loss of landscape elements, even in remote areas. We estimated changes in bird species composition in a characteristic highland agricultural area of 50 km² in Central Greece, which is undergoing major landscape changes. No decadal bird census series for diachronic correlation to landscape condition are available, so we resorted to spatial comparison as a proxy to temporal trends. The study was conducted in three phases, spread over three post-migration spring seasons. In Phase A differences were detected in species composition between areas where land use had undergone changes (detected through retrospective remote sensing) and nearby 'control' areas which had remained unchanged over 40 years, thus establishing the possible linkage of bird species to landscape types. In phase B we determined through an ordination study which landscape features have the strongest explanatory potential for species composition. In phase C we studied bird occupancy of landscape types and their linkage to landscape attributes in randomly distributed observations. In a final survey we tried to establish through remote sensing to what degree landscape features had changed over more than 4 decades, in order to conjecture how bird populations may have been affected. Even at the small scale of the study area and the proximity of respective landscape types ornithofauna is spatially differentiated, with a net impoverishment in species richness in 'new' landscape types. Previously non-existing, planted forest types did not recruit the original tree-related fauna. Openness of the landscape and the deciduous vs. evergreen character of the vegetation were the most important landscape features determining species composition. The observed landscape changes must have affected bird populations, in view of their relative faithfulness to particular landscape features, which are being lost over time. If considering bird species with a status of concern to the European Bird Directive (eight annex 1 listed species) we must conclude that this area, though not listed for NATURA2000, is undergoing cryptic but rapid losses in both landscape features and ornithofauna in spite of a general perception of its small-scaled, little affected nature.

Keywords: sub-Mediterranean and temperate scrub, land use change, Bird Directive, Greece, remote sensing

Introduction

Mediterranean landscapes are characterised by a mosaic structure as a result of human activities such as agriculture, livestock grazing, irrigation, cutting and burning. Anthropogenic activities have influenced the Mediterranean area for millenia and a complex co-evolution between man and the ecosystem is its main characteristic (Grove & Rackham, 2003). However, the last decades intensification of agrarian activities and methods has accelerated and it has changed this co-evolution. Bird population declines have been associated with this agricultural intensification (Tucker & Heath 1994; Chamberlain *et al.* 2000; Donald *et al.* 2001). The effects of landscape changes on birds, resulting from a landscape alteration, have been scarcely studied in the eastern part of the Mediterranean Basin, especially in Greece. We studied and documented vegetational changes and effects of vegetation structures and landscape attributes on bird populations in different landscape types in a central Greek agricultural area. In Thessaly (North Greece), near the village of Dolichi (altitude 500m-800m) habitat

composition in terms of vegetation structure and landscape attributes were measured and the bird composition was assessed. This landscape was reported to be small scaled and well preserved over time (pers. comm. Greeks scientists), we therefore performed a decadal diachronic assessment of landscape change using aerial photographs and satellite imagery. With this approach we wish to answer: (1) did landscape and vegetation structure of the study area change over four decades? (2) can we make a more objective landscape classification based on vegetation structures and landscape attributes than our initial *a priori* human categorization?

This allows us to conjecture (3) how bird communities may have been affected by landscape alteration over four decades? The research was spread over 3 consecutive years 2003, 2004, 2005 (respectively phases A, B and C).

Materials and methods

The study area (ca. 40°03'39"N, 22°09'53"E) covers 4900 ha, comprising the small village of Dolichi (altitude 500m-800m), 21 km north-west of Elassona (Thessaly), Central Greece. Data were collected on basis of the interpretation of digitalised and georeferenced aerial photographs of 1960, a pan-sharpened multi-spectral Quickbird Satellite Image of 2003 with a spatial resolution of 0.6 m and field survey done in 2004-2005. The processing of these data was done using GIS, ArcGIS 8.1 and ArcView 9.

Phase A and B: The birds were censused in April and May 2003 and 2004 by observation walks along predetermined line transects recording all birds heard and seen for 50 min. We defined four *a priori* defined landscape types on basis of which we separated observations: (1) agricultural hedgerows, (2) grasslands with dispersed *Pyrus amygdaliformis*, (3) 'dehesa', (4) rivulet accompanying vegetation.

Phase C: The birds were censused in May 2005 using the fixed-radius point counting method with a radius of 50m (Hutto *et al.*, 1986). At each census point bird species seen or heard were recorded during 15 min, preceded by an initial 5 min period for birds to settle. Landscape and habitat information within the 50m radius around the observer and data concerning the surrounding matrix within a 100m radius were also gathered.

We drew 98 census points by stratified random sampling of 8 predefined vegetation types using ArcGIS and Excel software. Eight landscape units were identified on basis of the presence and spatial distribution of dominant vegetation and landscape elements and land use. These 8 types are: (1) Agricultural fields; (2) Plantations; (3) Grasslands with *Quercus coccifera* and grasslands with *Pyrus amygdaliformis*; (4) 'Dehesas'; (5) Thickets; (6) Badlands; (7) Rivulet accompanying vegetation ; (8) Agricultural hedgerows. The bird composition analysis was done using TWINSpan and CANOCO (version 4.5; ter Braak and Šmilauer, 2002)

Results and discussion

In a first phase A we looked at the relationship between avian species composition and landscape or habitat change. We compared ornithofauna in plots where land use had undergone change (change detection by comparing aerial photographs of 1960,1995, Quickbird satellite image 2003) and nearby - originally similar - 'control' areas which had remained unchanged over 40 years using spatial comparison as a proxy for temporal change. We focused on human-perceived landscape patterns and measures of species occurrence like species richness, Shannon-Wiener diversity index and Jaccard similarity

index. Using the observed spatial differences in bird composition as a proxy, we suspect landscape and habitat changes which have taken place over 40 years as a result of anthropogenic activities, may have caused decreases in bird species richness and diversity in the study area.

In a second phase B we established through an ordination study which landscape features have the strongest explanatory potential for species composition. An indirect ordination (PCA) was applied to the bird data to possibly identify aspects of the landscape which may be important for birds without *a priori* consideration of the types considered. The grouping of the bird data in the diagram indicates that (1) the deciduous or evergreen nature and (2) the open or dense (linear) character of the vegetation are the determining factors for the ornithofauna in the study area. This gradient of landscape units varying progressively from a closed to open landscapes is consistent with the results of, amongst others, Arnold (1983), Balent and Courtiade (1992), Preiss *et al.* (1997).

In a third phase C we studied bird occupancy of landscape types and their linkage to landscape attributes in randomly distributed observations in order to avoid *a priori* biased landscape and ornithofauna categorization. The bird composition analysis was done using TWINSPLAN and CANOCO. The analysis shows a major consistency of bird species and vegetation structure and landscape attributes at community and species level. Openness of the habitat, crop cover, number of vegetation patches, grazing pressure and richness of the herb layer were shown to affect bird species community composition. At species level different sets of landscape attributes sustain different habitat uses. *Lanius minor* and *Lanius collurio* for example, both listed in Annex 1 of the European Bird Directive (79/409/EEC), show a high consistency for foraging within the *Pyrus amygdaliformis* grasslands. *Melanocorypha calandra*, also listed in Annex 1 of the European Bird Directive, shows a high consistency with large agricultural fields. As an example, these landscape types have not been maintained in a same proportion over time in the study area (following section).

In a final survey we tried to establish to what degree landscape features were modified over more than 4 decades. Results were combined from the landscape classification on the satellite image of 2003, the interpretation of the aerial photograph of 1960, the field survey in 2005 and interviews with local farmers and villagers. The study area experienced characteristic and dramatic trends coinciding with landscape modification at a decadal timescale: (i) increase of agricultural cropland (fields), (ii) shift from small-scale to large-scale agricultural land uses, (iii) simplification of landscape types due to a decrease of small and linear landscape attributes in agricultural fields (hedges, dry stone walls, 'dehesa'-type), (iv) decrease of natural landscape types, especially *P.amygdaliformis* grasslands and (v) shift from wet, mixed evergreen-deciduous rivulet accompanying vegetation to a dry more evergreen rivulet accompanying vegetation. McIntyre & Hobbs (1999) pointed out that as landscape modification increases, more native vegetation is lost, land-use intensity in modified areas increases, and remnants of native vegetation are increasingly influenced by processes originating in modified areas. Human-modified landscapes endure some common spatial patterns including the perforation, dissection, sub-division, shrinkage, and attrition of native vegetation (Forman, 1995; Fahrig, 2003).

Conclusions

Even at the small scale of the study area and with the close proximity of respective landscape types ornithofauna is spatially differentiated, with a net impoverishment in species richness in ‘new’ landscape types. The explicit landscape and habitat changes for the last decades as a result of anthropogenic activities indicate a possible decreasing bird species richness and diversity in the study area, taking spatial comparison as a proxy for temporal change. Natural and semi-natural landscape types shift towards large-scale agricultural fields and consequently bird species communities must shift toward a homogeneous, rural species community, characterised by few species with higher abundances.

Landscape types as recognized *a priori* by the human eye are not necessarily ‘seen’ and used as such by the ornithofauna. Openness of the landscape and the deciduous vs. evergreen character of the vegetation were the most important landscape features. Relative faithfulness of many species to landscapes with certain attributes suggests that major losses must have taken place over the last decades and are probably ongoing. Previously non-existing, planted forest types (*Robinia pseudoacacia*, *Juglans* spp.) did not recruit the original tree-related fauna with the exception of the Golden Oriole (*Oriolus oriolus*). Plantations are of lower value for birds since they comprise a reduction in tree species diversity, simplification of structure, diminishment in the abundance of mature trees and dead wood (Ausden, 2005).

The analysis shows a major consistency of bird species and vegetation structure and landscape attributes at community and species level. Openness of the habitat, crop cover, number of vegetation patches, grazing pressure and richness of herb layer were shown to affect bird species community composition. At species level different sets of landscape attributes sustain different habitat uses. *Lanius minor* and *Lanius collurio* for example, both listed in Annex 1 of the European Bird Directive (79/409/EEC), show a high consistency for foraging with the fast disappearing *Pyrus amygdaliformis* grasslands. *Melanocorypha calandra*, also listed in Annex 1 of the European Bird Directive, shows however a high consistency with large agricultural fields, which increase in share. If considering bird species with a status of concern to the European Bird Directive (8 annex 1 listed species) we must conclude that this area, though not listed for Natura2000, is undergoing cryptic but rapid losses in both landscape features and ornithofauna, in spite of a general perception of its small-scaled, little affected nature. In a country where even Natura2000 (Bird Directive sites) cannot be managed appropriately (Bazigou *et al.*, 2008 POSTER), the challenge for areas such as the Dolichi landscape we studied seems considerable.

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