New approach in data analysis from areas with limited ornithological data: automated modelling of small passerine densities from approximate transects

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Introduction

Ornithological data, in comparison to data for other biological groups, is often regarded as one that is most easily obtainable and birds are among best known organisms.

Birds are indicators of environmental changes and good surrogate for ecological value of an area. For that reason, in Europe, data on birds and habitats are used as main pillars to advocate the conservation of nature in whole, through the Bird's and Habitat's Directives. Number of scientific and non-governmental organisations developed variety of monitoring programs in order to resolve questions on bird distributions, population statuses and diverse population parameters. Some Western European countries and North America, this period in time regard as time "beyond data gathering" where the usage of novel statistical techniques developed, enables us to answer more complex ecological questions that was not possible in the recent past. In the same time, vast amount of available remotely sensed data opened possibility to monitor bird habitats on a large scale, and more useful planning of corridors and stop-over sites as well as facilitate multispecies management.

But, situation about bird data is far from described in large part of the world and usage of every information available is necessary.

Our test region was middle part of Croatian coastal part of a country that can be regarded as region with limited ornithological data.

Materials and Methods

Data used for modelling was start and end point of the 35 transect from Dalmatia and number of 28 species in focus. Then we did the following:

1) Reconstruct transects, approximating it with straight line between start and end point.
2) Merging transect lines with species information in SpatialLineDataFrame and save ESRI Shapefiles and KML files for checking;
3) Calculating species densities along every transects knowing species counts and length of the transects;
4) Creating profiles from line transects, information at every 10 meters along transects for following environmental variables prepared at 30 meter resolution:
   - elevation; - aspect; - slope; distance to the coast;
   - first three PCA of worldclim bioclimatic variables ;
   - national habitat classification scheme – 3rd level;
   - Corine land cover classification scheme – 3rd level;
5) Information from profiles were integrated at transect level.
6) The same set of variables prepared at 1km resolution for creating final spatial models.
7) Automated modelling procedure was performed for each species in dataset in order to detect important environmental variables.
8) Creating spatial predictions (regression-kriging) according to the best model and fitted variogram of residuals for each out of 28 species in focus.

Results

We developed automated spatial modelling of densities for small passerine bird species through approximate transects that connects start and end points, information usually available from bird monitoring projects in the region.

Both, national habitat classification schemes and Corine land cover information can be used in proposed methodology. Here, we are presenting Corine approach due to pan European characteristics of Corine classification.

Presented results are preliminary results of GLM modelling, testing all possible models up to 5 variables and comparing among themselves according to Aikake Information Criterion (AIC).

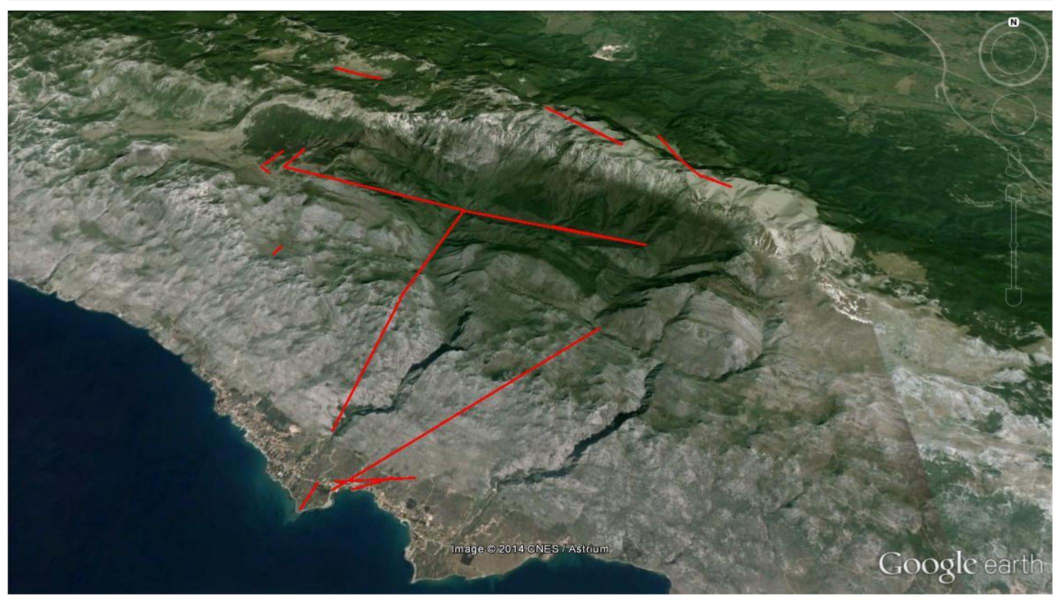

Figure 1. Some of the reconstructed transects used for modelling.

Table 1. Best models for each species, selected according AIC. PCA1, PCA2 and PCA3 are first three components of principal component analysis performed at bioclim variables (http://www.worldclim.org).

Table 2. Corine land cover legend.

Species	Best model
Parus major	hab_11 + hab_23 + PCA1 + slope
Sylvia atricapilla	hab_27+hab_28+PCA3
Oriolus oriolus	hab_24
Jynx torquilla	hab_2+hab_24+PCA1+slope
Serinus serinus	hab_2+hab_24+PCA1+slope
Turdus merula	hab_27+hab_28+hab_29+PCA3
Fringila coelebs	hab_24+hab_28+hab_29+PCA2
Upupa epops	hab_28+hab_29
Coccothraustes coccothraustes	hab_2+hab_24+hab_44+PCA2
Acantis canabinna	hab_27
Acipiter nisus	hab_11+hab_2+hab_29+PCA2
Luscinia megarhynchos	hab_11+hab_2+hab_44+PCA3
Sylvia hortensis	hab_11+hab_28+hab_29+PCA3
Sylvia cantillans	hab_11+hab_21+hab_29+PCA2
Parus caeruleus	hab_26+hab_27+hab_44+PCA3
Aegithalos caudatus	hab_28
Lanius collurio	hab_29+hab_32+PCA1+slope
Parus lugubris	hab_2+hab_28+hab_44+PCA2
Cuculus canorus	hab_11+hab_2+hab_24+hab_44
Dendrocopus major	hab_24+hab_28+hab_44+PCA3
Erythacus rubecculla	aspect+hab_11+hab_2+hab_44
Sitta europaea	hab_11+hab_21+hab_44+slope
Turdus viscivorus	hab_11+hab_21+hab_28+hab_44
Picus canus	hab_2
Prunella modularis	hab_23+hab_27
Phylloscopus collybita	hab_11+hab_27+hab_29+PCA1
Anthus trivialis	dist_coast+hab_23+PCA1+PCA2
Phoenicurus ochruros	hab_11+hab_2+hab_44+slope

Hab	Corine code
1	1.1.1 Continuous urban fabric
2	1.1.2 Discontinuous urban fabric
3	1.2.1 Industrial or commercial units
4	1.2.2 Road and rail networks and associated land
5	1.2.3 Port areas
6	1.2.4 Airports
7	1.3.1 Mineral extraction sites
8	1.3.2 Dump sites
9	1.3.3 Construction sites
10	1.4.1 Green urban areas
11	1.4.2 Sport and leisure facilities
12	2.1.1 Non-irrigated arable land
13	2.1.2 Permanently irrigated land
14	2.1.3 Rice fields
15	2.2.1 Vineyards
16	2.2.2 Fruit trees and berry plantations
17	2.2.3 Olive groves
18	2.3.1 Pastures
19	2.4.1 Annual crops associated with permanent crops
20	2.4.2 Complex cultivation patterns
21	2.4.3 Land principally occupied by agriculture, with significant areas of natural vegetation
22	2.4.4 Agro-forestry areas
23	3.1.1 Broad-leaved forest
24	3.1.2 Coniferous forest
25	3.1.3 Mixed forest
26	3.2.1 Natural grasslands
27	3.2.2 Moors and heathland
28	3.2.3 Sclerophyllous vegetation
29	3.2.4 Transitional woodland-shrub
30	3.3.1 Beaches, dunes, sands
31	3.3.2 Bare rocks
32	3.3.3 Sparsely vegetated areas
33	3.3.4 Burnt areas
34	3.3.5 Glaciers and perpetual snow
35	4.1.1 Inland marshes
36	4.1.2 Peat bogs
37	4.2.1 Salt marshes
38	4.2.2 Salines
39	4.2.3 Intertidal flats
40	5.1.1 Water courses
41	5.1.2 Water bodies
42	5.2.1 Coastal lagoons
43	5.2.2 Estuaries
44	5.2.3 Sea and ocean

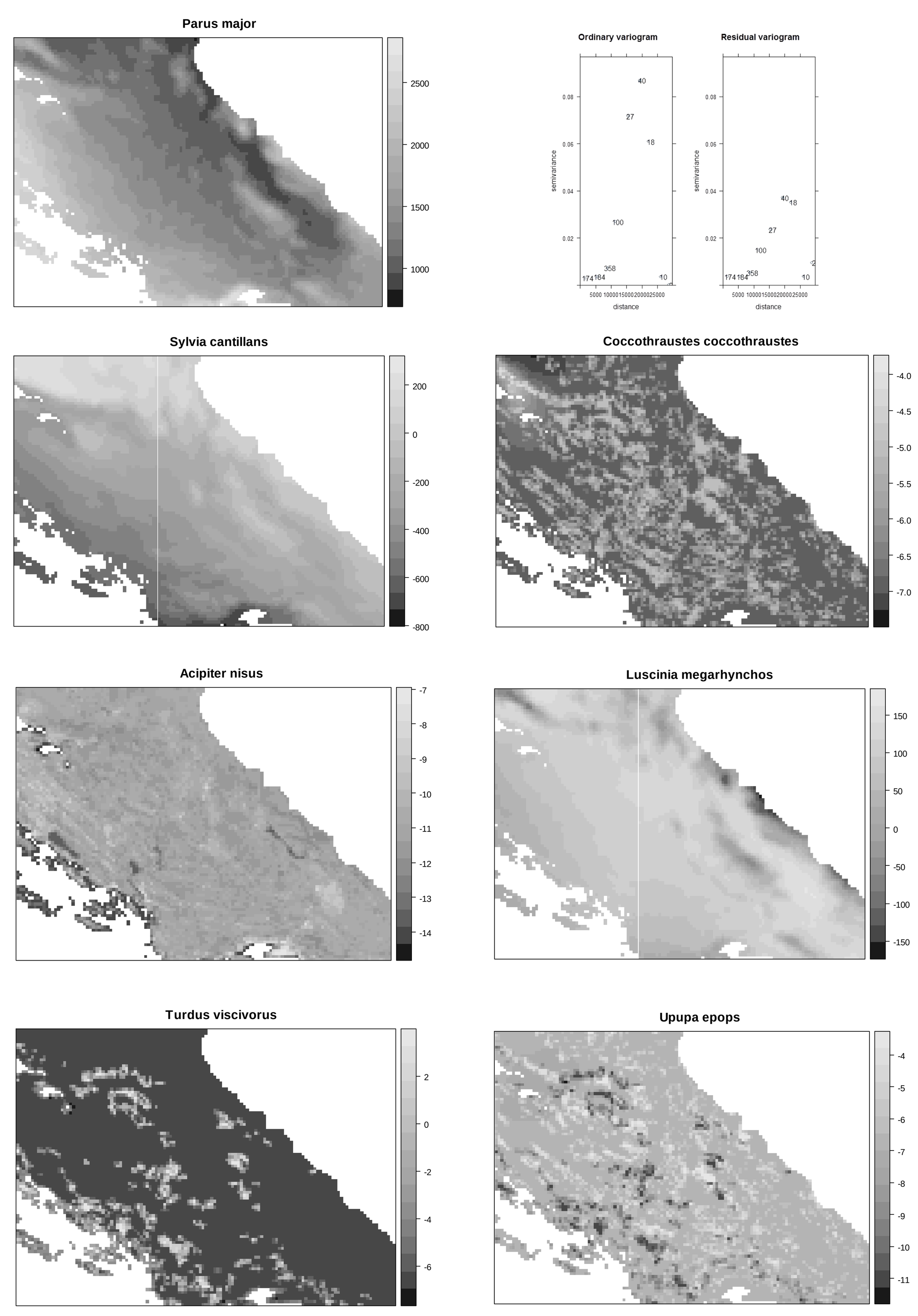

Figure 2. Spatial predictions of log (densities) for selected species and example of one ordinary/residual variogram.

Discussion

With this exercise we tried to find a way how to use all available data on bird communities in a region with limited ornithological data. Similar approach can be made with other biological taxa.

We clearly showed the potential of such approach in obtaining new knowledge about the species – environment relationship.

Our dataset was restricted in space, no temporal replicates as well as very small in total number of transects, so obtained results should be taken with care. Anyway, even such a restricted starting information gave us much better insight in variables that probably plays important role in determining species densities in the region.

It is necessary to quantify the discrepancies in results obtained through our approach of transect approximation with results obtained having exact transect route available. For that, we need to set well planed field experiment.

Conclusions

Suggested approach can be very useful in regions with limited number of skilled ornithologists / birdwatchers in order to use as much available information about birds from diverse projects.

It is necessary to incorporate larger number of transects in order to detect:

1) Autocorrelation in the densities of species in focus since this dataset was too small for reliable estimation;
2) Regional differences in variable importance;
3) Species potentially susceptible to climate change;
4) Changes in species – environment relationship through time (transects grouped to suit the most to national habitat mapping projects or Corine project.

Contact

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