Migratory connectivity analysis

by EURING Migration Atlas

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1.1 Connectivity between individuals

The analysis evaluated 2380 individuals (4760 encounters) filtered from a total of 211655 records in the EURING databank which were considered for the Atlas. The species shows a significant connectivity from clustering, with a number of first-level clusters = 3 (Table 16530-1; Figure 16530-1).

Table 16530-1. Results from the migratory connectivity analysis. For each cluster, the degree of connectivity (r_M), its statistical significance (p-value) and 95% confidence interval limits are shown. When the p-value is less than or equal to 0.1, the degree of clustering structure (oasw) and the best number of clusters identified are reported.

Cluster name	Level of clustering	N individuals	Migratory connectivity (r_M)	p-value	Lower 95% confidence limit	Upper 95% confidence limit	Best number of clusters	oasw
0	0	2380	0.958	0.001	0.946	0.969	3	0.777
1	1	225	0.761	0.001	0.675	0.849	9	0.671
2	1	2009	0.732	0.001	0.672	0.795	8	0.466
3	1	146	0.640	0.001	0.474	0.876	2	0.640
11	2	4	-	-	-	-	-	-
12	2	24	0.655	0.001	0.491	0.998	4	0.606
13	2	10	-	-	-	-	-	-
14	2	31	0.631	0.001	0.395	0.865	9	0.590
15	2	14	-	-	-	-	-	-
16	2	5	-	-	-	-	-	-
17	2	12	-	-	-	-	-	-
18	2	119	0.822	0.001	0.699	0.956	9	0.913
19	2	6	-	-	-	-	-	-
31	2	36	0.456	0.001	0.289	0.741	7	0.417
32	2	110	0.791	0.001	0.526	0.996	7	0.709
121	3	16	-	-	-	-	-	-
122	3	3	-	-	-	-	-	-
123	3	1	-	-	-	-	-	-
124	3	4	-	-	-	-	-	-
141	3	6	-	-	-	-	-	-
142	3	1	-	-	-	-	-	-
143	3	11	-	-	-	-	-	-
144	3	1	-	-	-	-	-	-
145	3	3	-	-	-	-	-	-
146	3	1	-	-	-	-	-	-
147	3	2	-	-	-	-	-	-
148	3	1	-	-	-	-	-	-

Cluster name	Level of clustering	N individuals	Migratory connectivity (r_M)	p-value	Lower 95% confidence limit	Upper 95% confidence limit	Best number of clusters	oasw
149	3	5	-	-	-	-	-	-
181	3	5	-	-	-	-	-	-
182	3	1	-	-	-	-	-	-
183	3	2	-	-	-	-	-	-

Figure 16530-1. Map showing 95% kernel contours of of first-level clusters identified by the migratory connectivity analysis, if any, or 95% kernel contours of all encounters, in case of no clustering structure. Solid lines indicate the clusters in the breeding range, dotted lines those in the non-breeding range. Different contour colours correspond to different clusters, as reported in legend. The species distribution range is

also shown (breeding range: blue; non-breeding range: dark grey; resident range: beige; from BirdLife International, 2019).

1.2 Sensitivity analysis

Results of power analysis and validation. Analyses at the species level were re-run on subsamples of individuals of decreasing size (100 repetitions per subsample size), according to simple random sampling of individuals (Figure 16530-2) and stratified sampling of individuals within the breeding range (Figure 16530-3) and the non breeding range (Figure 16530-4). For stratified sampling, we selected individuals with a probability inversely proportional to the number of observation in each country. Figures below report the results of the procedure.
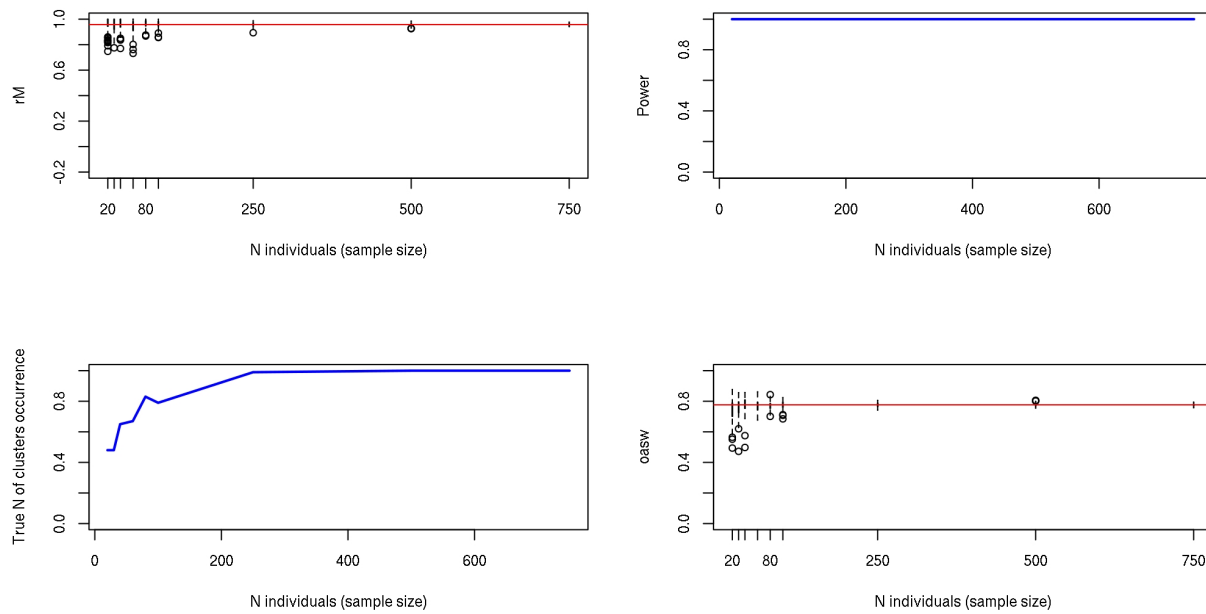

Figure 16530-2. Top left: simulated distribution (boxplots) and observed value (red line) of connectivity. Top right: Simulated power of the analysis (i.e. proportion of times the analyses on the subset of individuals was significant). Bottom left: Proportion of times the analysis provides the observed best number of cluster. Bottom right: simulated distribution (boxplots) and observed value (red line) of clustering intensity.
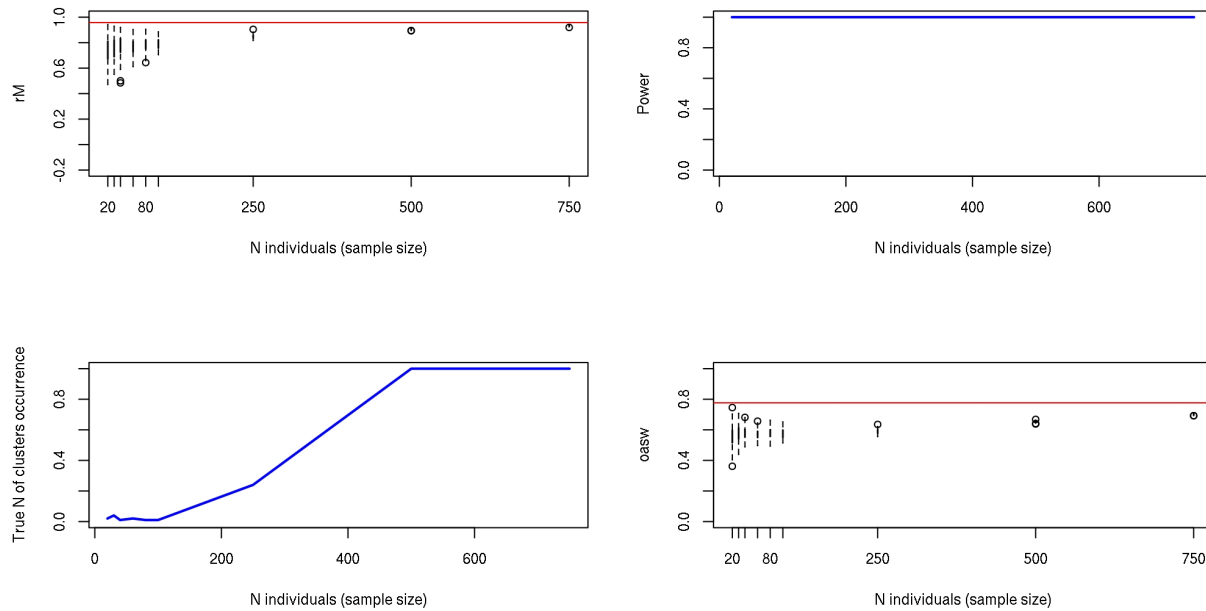
Figure 16530-3. Top left: simulated distribution (boxplots) and observed value (red line) of connectivity. Top right: Simulated power of the analysis. Bottom left: Proportion of times the analysis provides the observed best number of cluster. Bottom right: simulated distribution (boxplots) and observed value (red line) of clustering intensity.
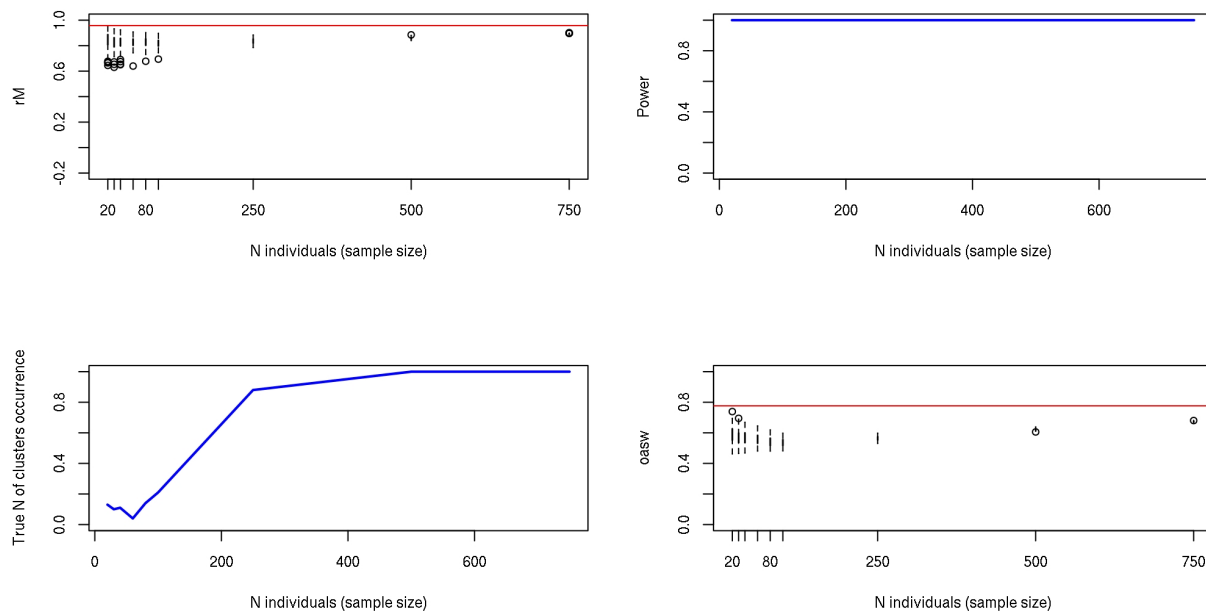

Figure 16530-4. Top left: simulated distribution (boxplots) and observed value (red line) of connectivity. Top right: Simulated power of the analysis. Bottom left: Proportion of times the analysis provides the observed best number of cluster. Bottom right: simulated distribution (boxplots) and observed value (red line) of clustering intensity.

The comparison between the bootstrapped distribution of r_M values from live recaptures and dead recoveries is significant ($p < 0.001$); Figure 16530-5).
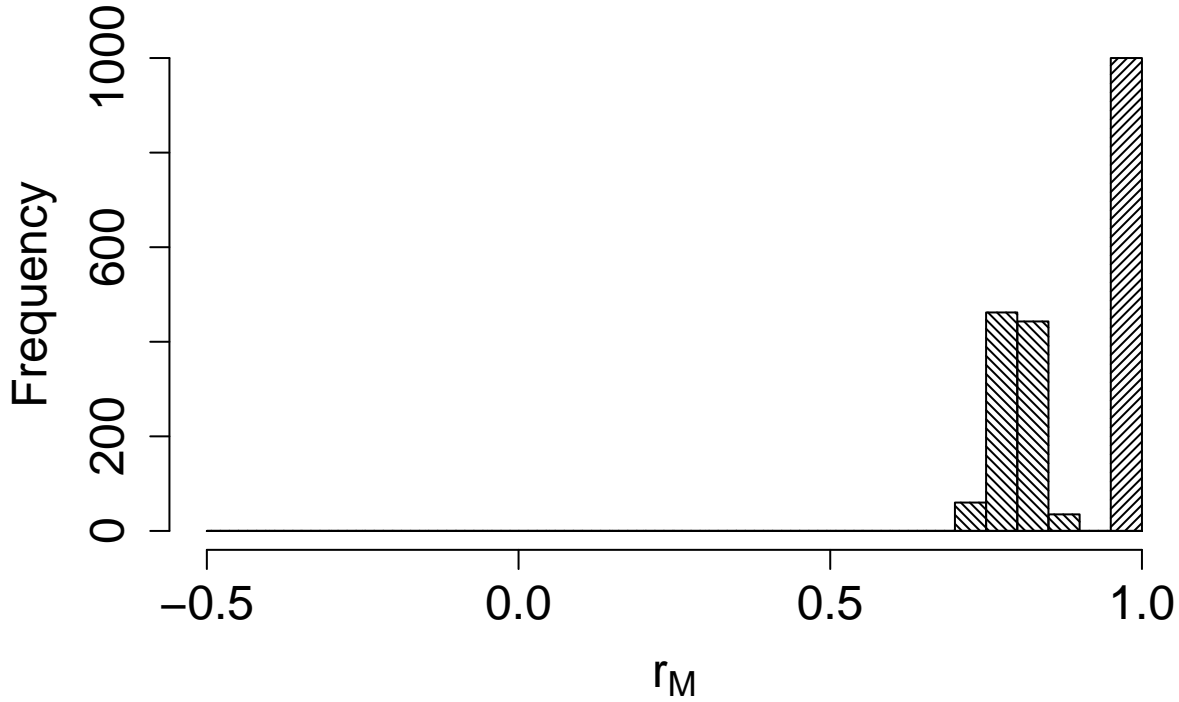

Figure 16530-5. Comparison between the bootstrapped distributions of connectivity value for alive recaptures (filling lines with angle=45°) and dead recoveries (filling lines with angle=375°).

2. Connectivity between pre-defined regions

The species shows high connectivity (MC = 0.922; MC = 0.922 when adjusted for absolute abundance) between 8 breeding regions and 8 non breeding regions (Table 16530-2; Figure 16530-6).

Table 16530-2. Transition probabilities between pre-defined regions. Estimated abundance (number of individuals) in each breeding region is also reported.

Breeding region	Abundance	Non breeding region	Transition probability
Central Europe	4910140	Central Europe	0.646
Central Europe	4910140	South-central Europe	0.042
Central Europe	4910140	South-east Europe	0.083
Central Europe	4910140	South-west Europe	0.208
Central Europe	4910140	West Europe	0.021
East Europe	5598404	Central Europe	1.000
North Europe	144700	North Europe	1.000
North-west Europe	3757547	North-west Europe	0.974
North-west Europe	3757547	South-west Europe	0.009
North-west Europe	3757547	West Europe	0.017

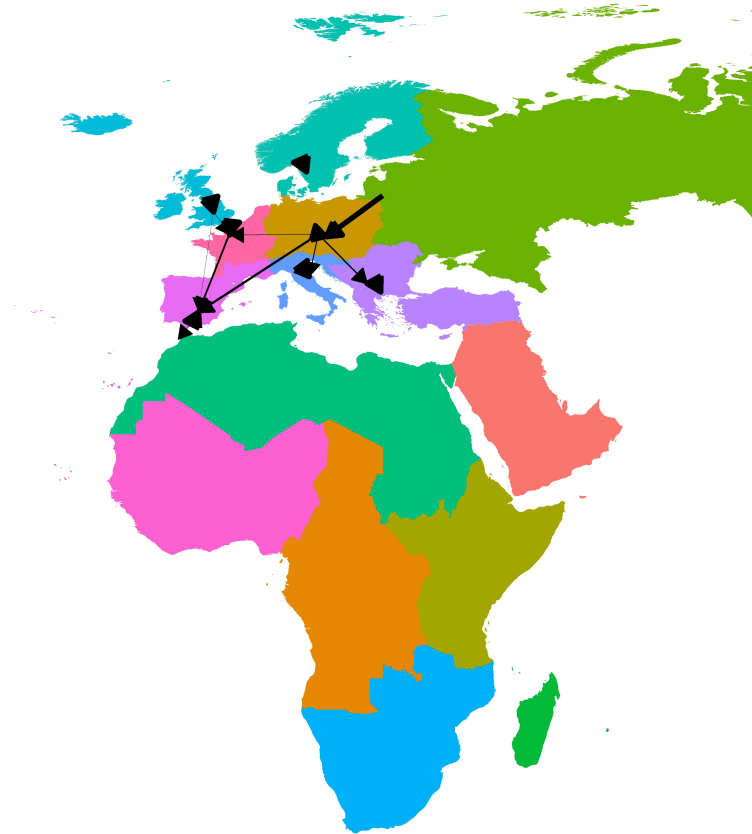| Breeding region	Abundance	Non breeding region	Transition probability
South-central Europe	3576042	South-central Europe	1.000
South-east Europe	12300000	South-east Europe	1.000
South-west Europe	36855959	North Africa	0.020
South-west Europe	36855959	South-west Europe	0.980
West Europe	1685556	South-west Europe	0.132
West Europe	1685556	West Europe	0.868

Figure 16530-6. Map showing pre-defined regions in different colours, with black arrows linking centroids of individual encounters in different regions. Arrow width is proportional to transition probability.

Reference

BirdLife International and Handbook of the Birds of the World (2019). Bird species distribution maps of the world. Version 2019.1. Available at http://datazone.birdlife.org/species/requestdis.