Migratory connectivity analysis

by EURING Migration Atlas

***Athene noctua* (EURING code 07570)**

1.1 Connectivity between individuals

The analysis evaluated 8628 individuals (17256 encounters) filtered from a total of 108395 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 = 2 (Table 07570-1; Figure 07570-1).

Table 07570-1. 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	8628	0.997	0.001	0.997	0.998	2	0.586
1	1	5376	0.996	0.001	0.995	0.997	3	0.536
2	1	3252	0.997	0.001	0.995	0.998	7	0.689
11	2	2017	0.982	0.001	0.974	0.989	9	0.547
12	2	3140	0.984	0.001	0.972	0.991	6	0.494
13	2	219	0.997	0.001	0.991	0.999	2	0.870
21	2	262	0.893	0.001	0.837	0.944	3	0.773
22	2	81	0.986	0.001	0.971	0.996	2	0.564
23	2	2313	0.884	0.001	0.826	0.926	2	0.636
24	2	419	0.813	0.001	0.733	0.884	2	0.629
25	2	70	0.952	0.001	0.883	0.998	3	0.774
26	2	50	0.997	0.001	0.994	0.999	4	0.705
27	2	57	1.000	0.001	1.000	1.000	4	0.793
111	3	223	0.961	0.001	0.944	0.977	2	0.478
112	3	534	0.860	0.001	0.805	0.918	8	0.420
113	3	286	0.904	0.001	0.854	0.956	2	0.497
114	3	211	0.826	0.001	0.770	0.934	2	0.570
115	3	225	0.737	0.001	0.603	0.866	4	0.439
116	3	306	0.823	0.001	0.762	0.874	3	0.532
117	3	112	0.775	0.001	0.686	0.876	2	0.537
118	3	12	-	-	-	-	-	-
119	3	108	0.818	0.001	0.613	0.961	2	0.568
131	3	6	-	-	-	-	-	-
132	3	213	0.972	0.001	0.950	0.988	2	0.417
211	3	108	0.823	0.001	0.579	0.935	3	0.817
212	3	14	-	-	-	-	-	-
213	3	140	0.508	0.001	0.184	0.789	4	0.553

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
221	3	63	0.961	0.001	0.891	0.990	8	0.534
222	3	18	-	-	-	-	-	-
231	3	212	0.952	0.001	0.901	0.984	3	0.825
232	3	2101	0.731	0.001	0.658	0.810	2	0.559
241	3	65	0.752	0.001	0.619	0.859	2	0.739
242	3	354	0.668	0.001	0.497	0.814	2	0.455
251	3	49	0.827	0.001	0.765	0.977	5	0.782
252	3	6	-	-	-	-	-	-
253	3	15	-	-	-	-	-	-
261	3	8	-	-	-	-	-	-
262	3	19	-	-	-	-	-	-
263	3	12	-	-	-	-	-	-
264	3	11	-	-	-	-	-	-
271	3	26	0.999	0.001	0.998	1.000	4	0.870
272	3	7	-	-	-	-	-	-
273	3	21	1.000	0.001	1.000	1.000	3	0.952
274	3	3	-	-	-	-	-	-

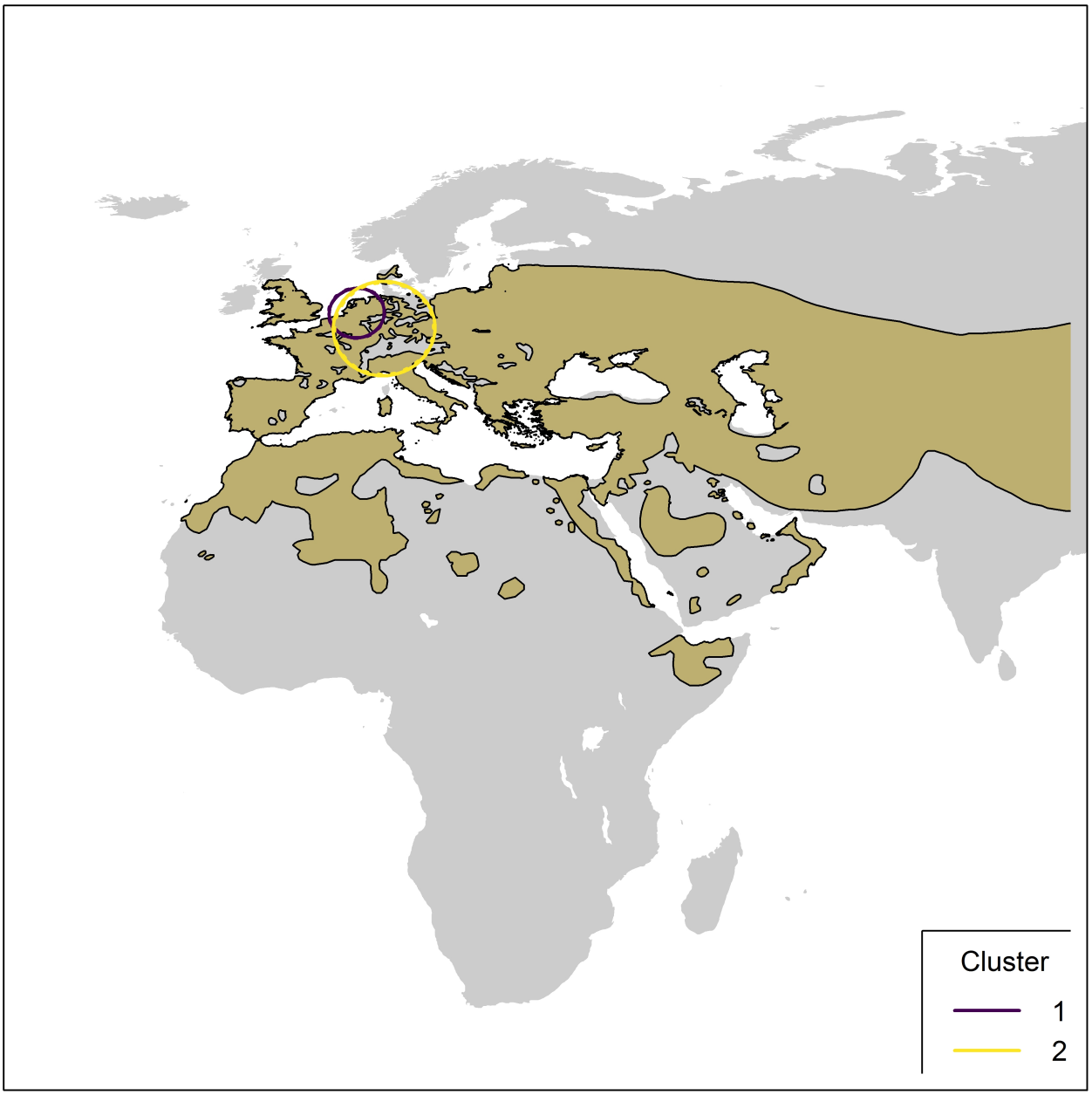

Figure 07570-1. Map showing 95% kernel contours of of first-level clusters identified by the migratory connectivity analysis, if any, or 95% kernel contours of all encounters, in case of no clustering structure. Solid lines indicate the clusters in the breeding range, dotted lines those in the non-breeding 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 07570-2) and stratified sampling of individuals within the breeding range (Figure 07570-3) and the non breeding range (Figure 07570-4). 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.

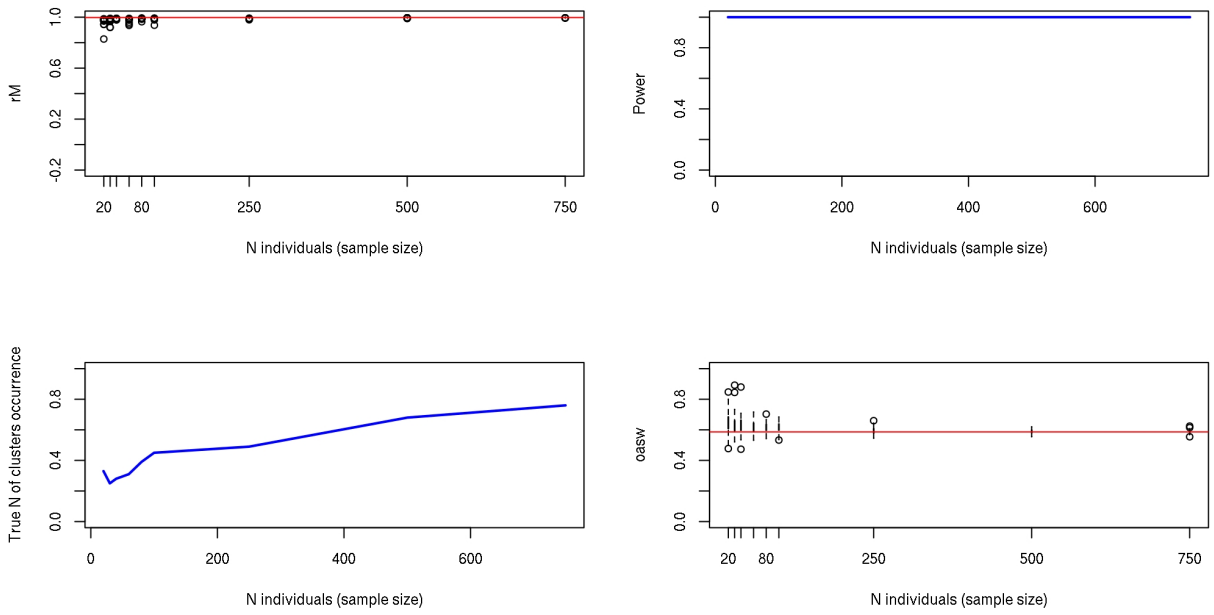

Figure 07570-2. Top left: simulated distribution (boxplots) and observed value (red line) of connectivity. Top right: Simulated power of the analysis (i.e. proportion of times the analyses on the subset of individuals was significant). Bottom left: Proportion of times the analysis provides the observed best number of cluster. Bottom right: simulated distribution (boxplots) and observed value (red line) of clustering intensity.

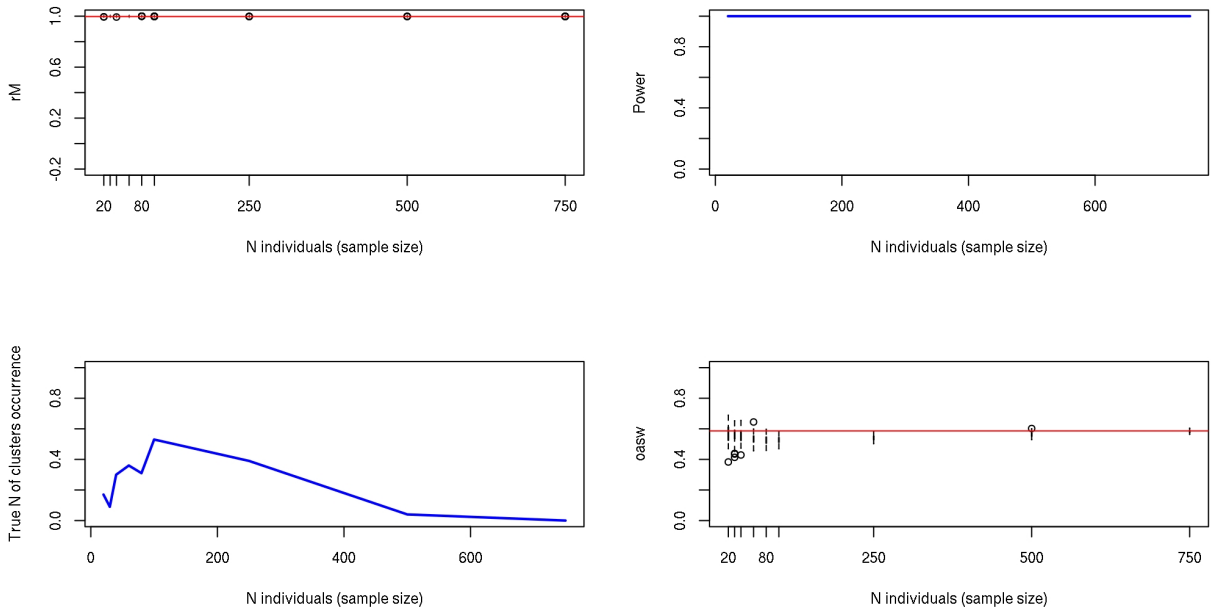

Figure 07570-3. Top left: simulated distribution (boxplots) and observed value (red line) of connectivity. Top right: Simulated power of the analysis. Bottom left: Proportion of times the analysis provides the

observed best number of cluster. Bottom right: simulated distribution (boxplots) and observed value (red line) of clustering intensity.

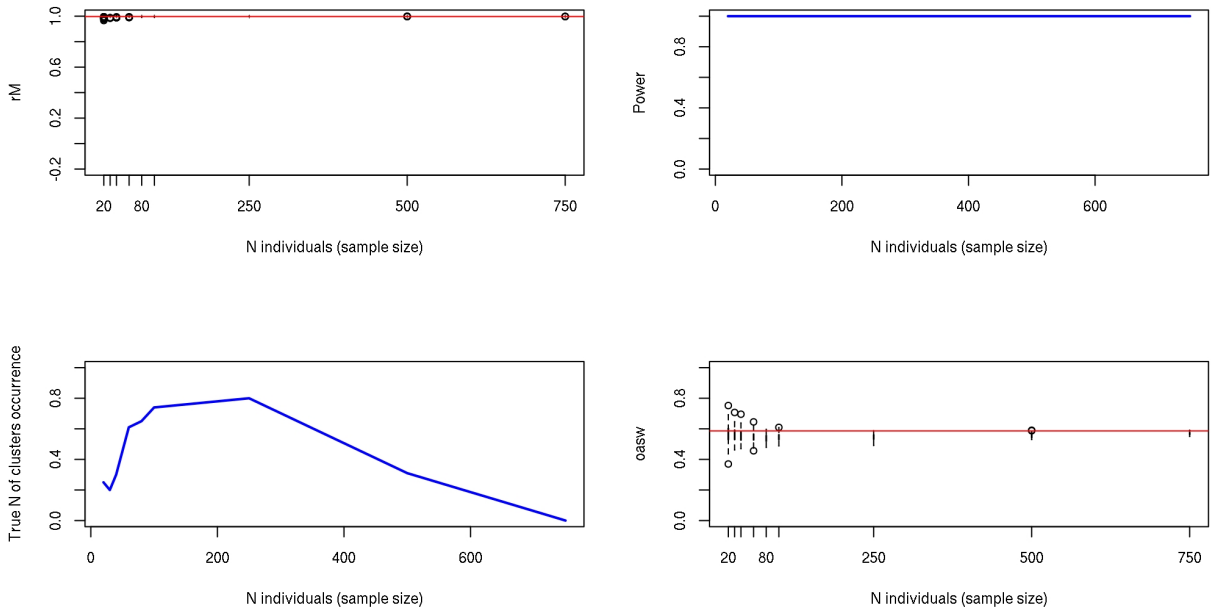

Figure 07570-4. Top left: simulated distribution (boxplots) and observed value (red line) of connectivity. Top right: Simulated power of the analysis. Bottom left: Proportion of times the analysis provides the observed best number of cluster. Bottom right: simulated distribution (boxplots) and observed value (red line) of clustering intensity.

The comparison between the bootstrapped distribution of r_M values from live recaptures and dead recoveries is not significant ($p = 1$); Figure 07570-5).

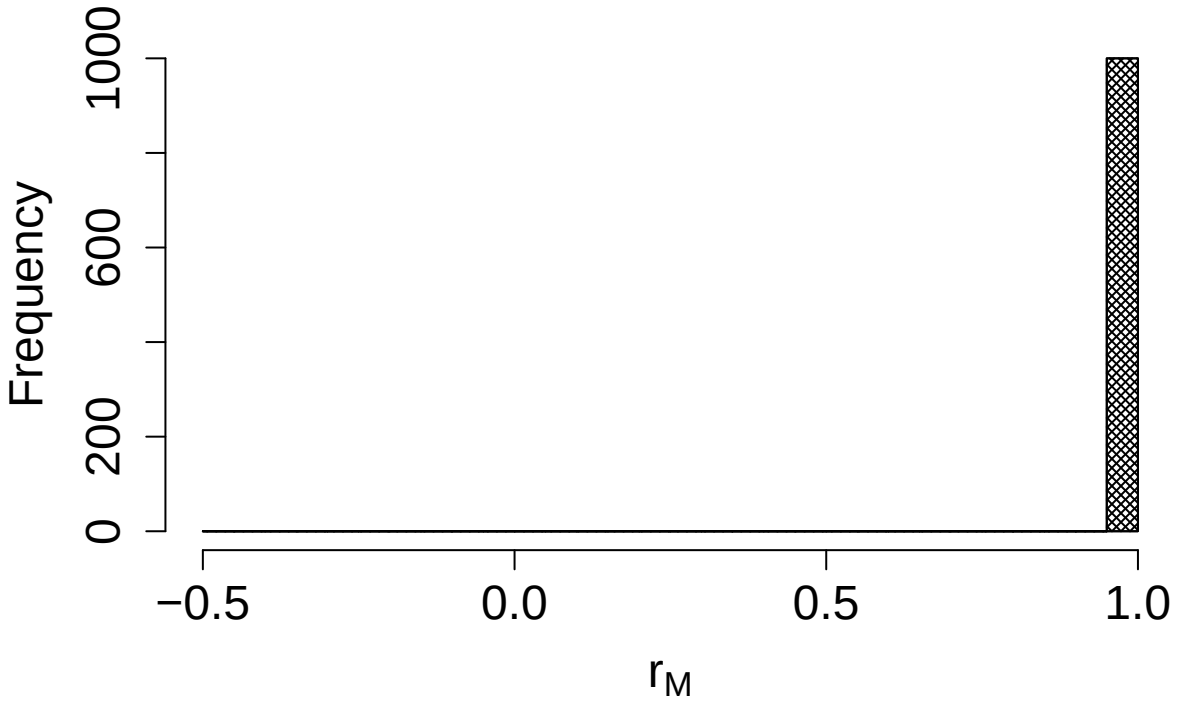

Figure 07570-5. Comparison between the bootstrapped distributions of connectivity value for alive recaptures (filling lines with angle=45°) and dead recoveries (filling lines with angle=375°).

2. Connectivity between pre-defined regions

The species shows high connectivity (MC = 1; MC = 1 when adjusted for absolute abundance) between 8 breeding regions and 8 non breeding regions (Table 07570-2; Figure 07570-6).

Table 07570-2. 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	24340	Central Europe	0.982
Central Europe	24340	South-west Europe	0.000
Central Europe	24340	West Europe	0.018
East Europe	158411	East Europe	1.000
North Europe	86	North Europe	1.000
North-west Europe	11400	North-west Europe	1.000
South-central Europe	120250	South-central Europe	1.000
South-east Europe	1086200	South-east Europe	1.000
South-west Europe	294061	South-west Europe	1.000
West Europe	87862	Central Europe	0.004
West Europe	87862	West Europe	0.996

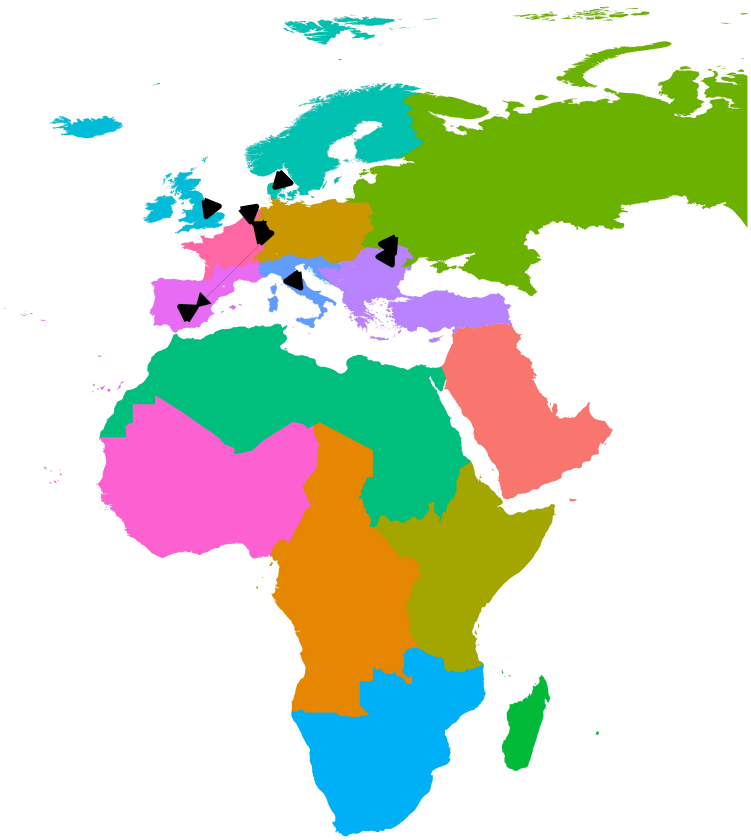

Figure 07570-6. Map showing pre-defined regions in different colours, with black arrows linking centroids of individual encounters in different regions. Arrow width is proportional to transition probability.

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.