

# Migratory connectivity analysis

by EURING Migration Atlas

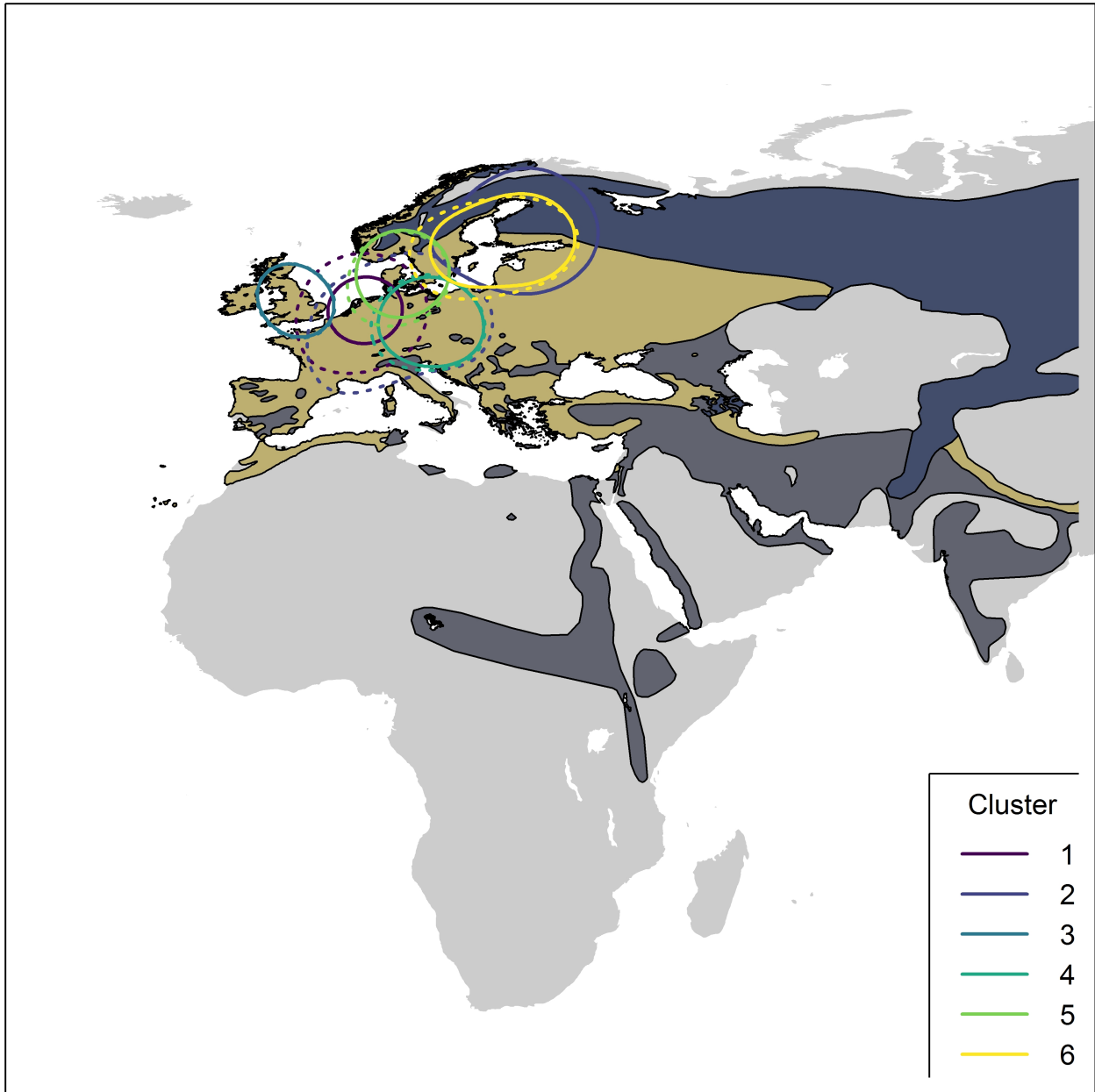
*Accipiter nisus* (EURING code 02690)

## 1.1 Connectivity between individuals

The analysis evaluated 3481 individuals (6962 encounters) filtered from a total of 66733 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 = 6 (Table 02690-1; Figure 02690-1).

**Table 02690-1.** 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	3481	0.533	0.001	0.505	0.563	6	0.516
1	1	1305	0.446	0.001	0.367	0.522	2	0.750
2	1	389	0.087	0.005	0.030	0.158	2	0.314
3	1	671	0.958	0.001	0.921	0.978	2	0.503
4	1	464	0.543	0.001	0.432	0.655	6	0.484
5	1	496	0.446	0.001	0.369	0.531	9	0.474
6	1	156	0.643	0.001	0.527	0.770	9	0.492
11	2	1205	0.590	0.001	0.532	0.659	3	0.420
12	2	100	0.123	0.022	0.031	0.267	3	0.343
31	2	302	0.974	0.001	0.917	0.990	6	0.576
32	2	369	0.896	0.001	0.836	0.941	4	0.550
311	3	6	-	-	-	-	-	-
312	3	3	-	-	-	-	-	-
313	3	143	0.814	0.001	0.723	0.898	2	0.413
314	3	88	0.709	0.001	0.571	0.848	6	0.357
315	3	32	0.668	0.001	0.436	0.988	2	0.515
316	3	30	0.918	0.001	0.792	0.990	2	0.591
321	3	34	0.770	0.001	0.597	0.932	3	0.470
322	3	148	0.516	0.001	0.292	0.701	7	0.381
323	3	164	0.724	0.001	0.609	0.838	2	0.460
324	3	23	0.975	0.001	0.943	0.993	4	0.768

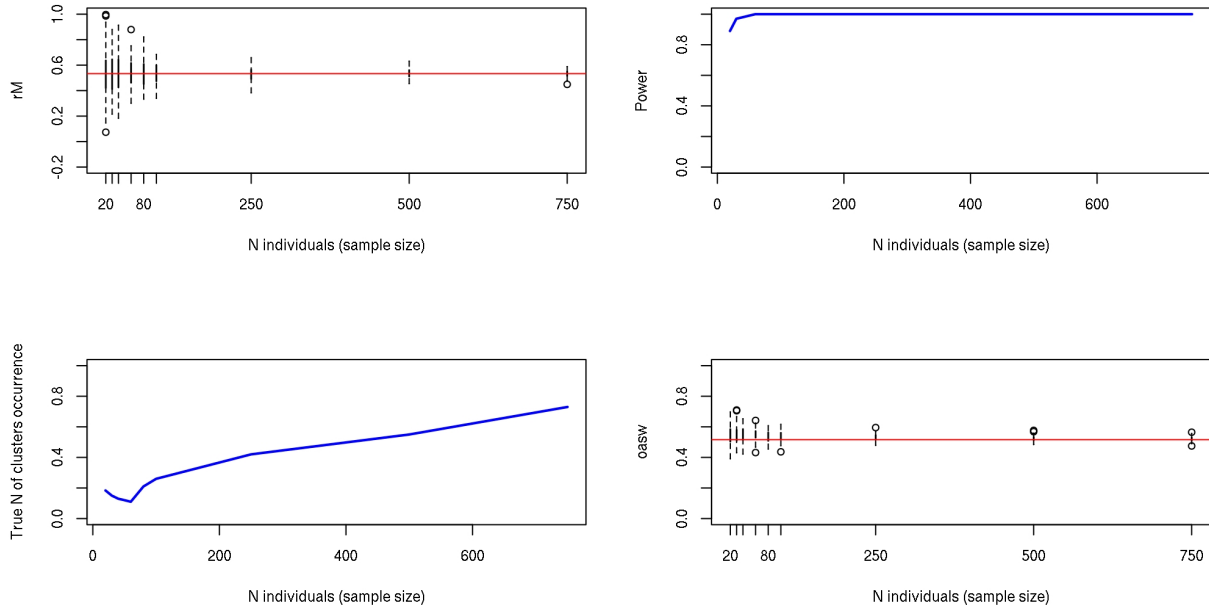


**Figure 02690-1.** Map showing 95% kernel contours of of first-level clusters identified by the migratory connectivity analysis, if any, or 95% kernel contours of all encounters, in case of no clustering structure. Solid lines indicate the clusters in the breeding range, dotted lines those in the non-breeding 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).

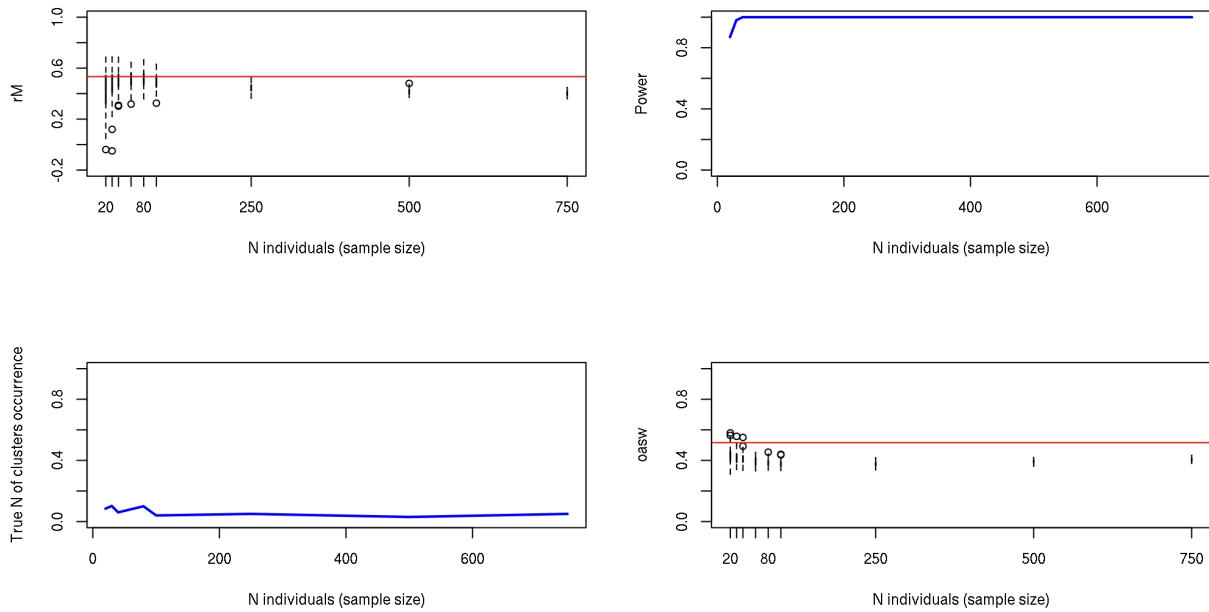
## 1.2 Sensitivity analysis

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 02690-2) and stratified sampling of individuals within the breeding range (Figure 02690-3) and the non breeding range (Figure 02690-4). 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.

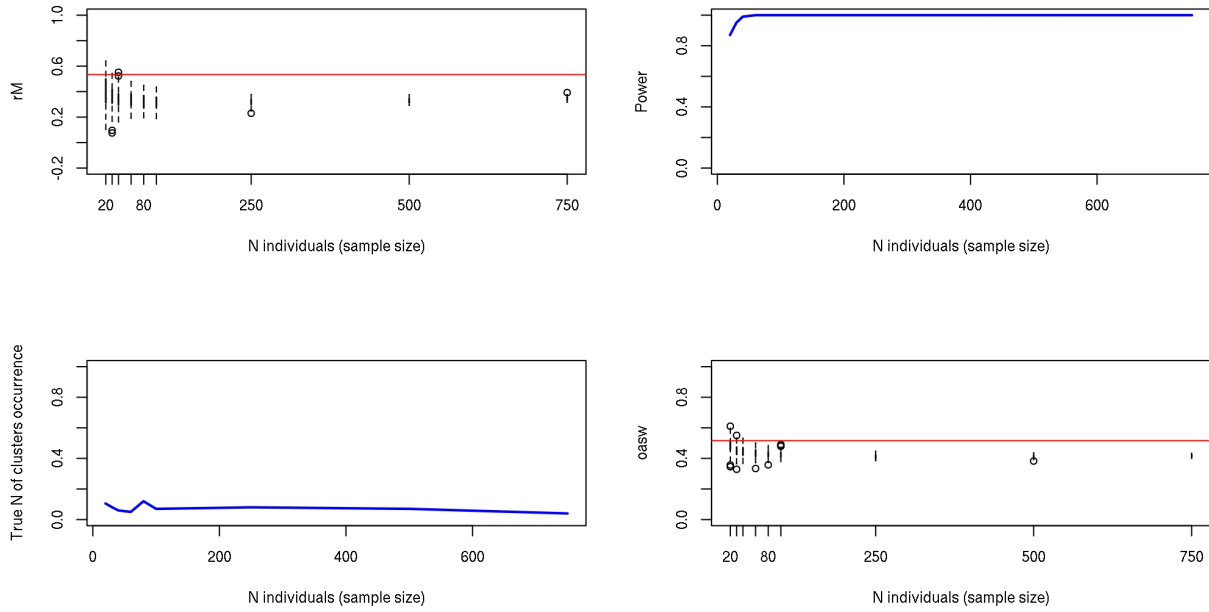


**Figure 02690-2.** Top left: simulated distribution (boxplots) and observed value (red line) of connectivity. Top right: Simulated power of the analysis (i.e. proportion of times the analyses on the subset of individuals was significant). Bottom left: Proportion of times the analysis provides the observed best number of cluster. Bottom right: simulated distribution (boxplots) and observed value (red line) of clustering intensity.



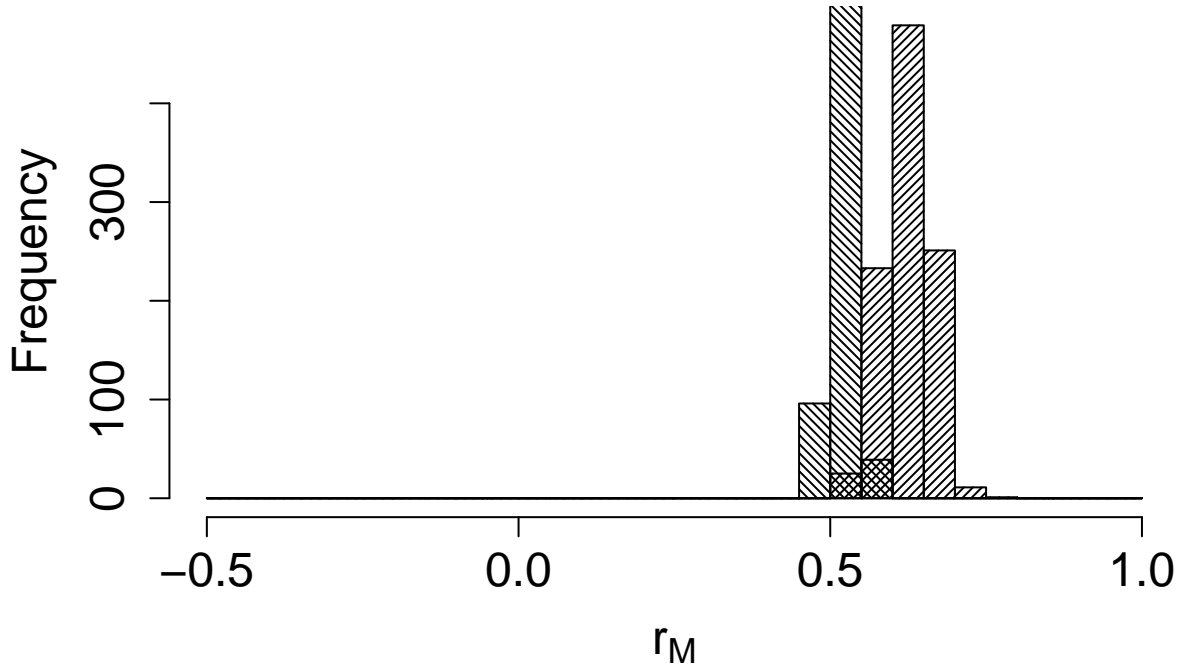
**Figure 02690-3.** Top left: simulated distribution (boxplots) and observed value (red line) of connectivity. Top right: Simulated power of the analysis. Bottom left: Proportion of times the analysis provides the

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



**Figure 02690-4.** 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 ( $p = 0.064$ ); Figure 02690-5).



**Figure 02690-5.** Comparison between the bootstrapped distributions of connectivity value for alive recaptures (filling lines with angle=45°) and dead recoveries (filling lines with angle=375°).

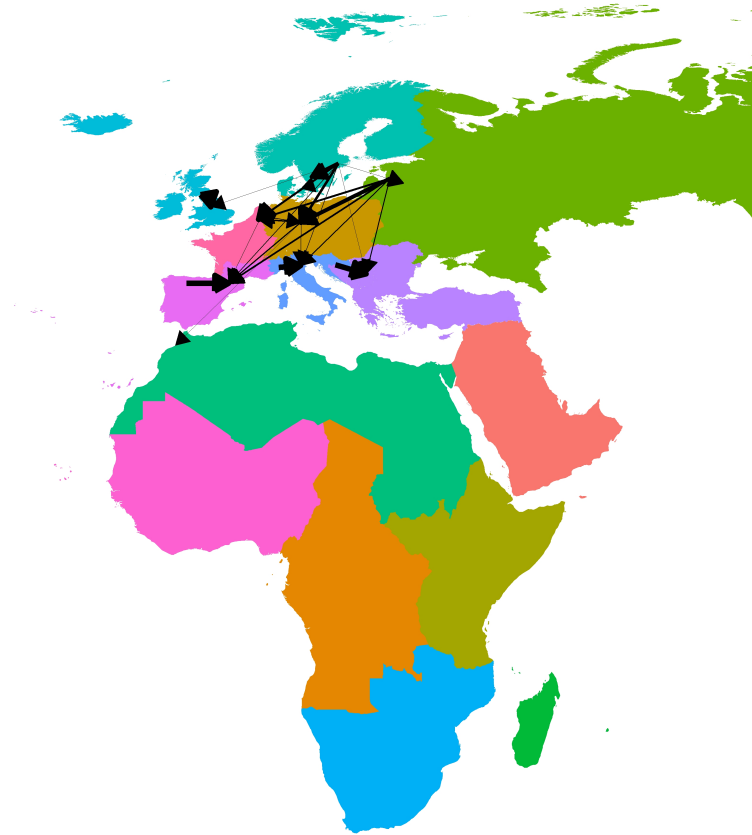
## 2. Connectivity between pre-defined regions

The species shows low/moderate connectivity ( $MC = 0.368$ ;  $MC = 0.368$  when adjusted for absolute abundance) between 8 breeding regions and 9 non breeding regions (Table 02690-2; Figure 02690-6).

**Table 02690-2.** 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	151125	Central Europe	0.865
Central Europe	151125	North Africa	0.001
Central Europe	151125	North Europe	0.004
Central Europe	151125	South-central Europe	0.009
Central Europe	151125	South-west Europe	0.051
Central Europe	151125	West Europe	0.070
East Europe	416390	Central Europe	0.538
East Europe	416390	East Europe	0.115
East Europe	416390	South-central Europe	0.038
East Europe	416390	South-east Europe	0.038
East Europe	416390	South-west Europe	0.115
East Europe	416390	West Europe	0.154
North Europe	119900	Central Europe	0.235

Breeding region	Abundance	Non breeding region	Transition probability
North Europe	119900	East Europe	0.004
North Europe	119900	North Europe	0.551
North Europe	119900	North-west Europe	0.003
North Europe	119900	South-central Europe	0.012
North Europe	119900	South-east Europe	0.007
North Europe	119900	South-west Europe	0.028
North Europe	119900	West Europe	0.160
North-west Europe	117860	North-west Europe	1.000
South-central Europe	21961	South-central Europe	1.000
South-east Europe	46460	South-east Europe	1.000
South-west Europe	49905	South-west Europe	1.000
West Europe	58779	Central Europe	0.027
West Europe	58779	South-west Europe	0.015
West Europe	58779	West Europe	0.958



**Figure 02690-6.** 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>.