Migratory connectivity analysis

by EURING Migration Atlas

***Aegithalos caudatus* (EURING code 14370)**

1.1 Connectivity between individuals

The analysis evaluated 11287 individuals (22574 encounters) filtered from a total of 372607 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 14370-1; Figure 14370-1).

Table 14370-1. 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	11287	1.000	0.001	1.000	1.000	3	0.747
1	1	1462	1.000	0.001	1.000	1.000	2	0.666
2	1	9150	0.999	0.001	0.998	0.999	3	0.465
3	1	675	0.997	0.001	0.990	1.000	9	0.675
11	2	1220	1.000	0.001	1.000	1.000	9	0.491
12	2	242	0.999	0.001	0.998	1.000	9	0.529
31	2	80	1.000	0.001	0.999	1.000	9	0.710
32	2	66	0.998	0.001	0.996	1.000	9	0.826
33	2	34	1.000	0.001	1.000	1.000	7	0.892
34	2	82	0.999	0.001	0.999	1.000	9	0.906
35	2	235	0.988	0.001	0.971	1.000	2	0.734
36	2	49	1.000	0.001	1.000	1.000	7	0.980
37	2	66	0.998	0.001	0.994	1.000	9	0.733
38	2	24	1.000	0.001	1.000	1.000	4	0.867
39	2	39	1.000	0.001	1.000	1.000	8	0.892
121	3	12	-	-	-	-	-	-
122	3	62	1.000	0.001	1.000	1.000	9	0.807
123	3	19	-	-	-	-	-	-
124	3	46	0.972	0.001	0.932	0.996	9	0.567
125	3	11	-	-	-	-	-	-
126	3	56	0.993	0.001	0.983	1.000	9	0.811
127	3	13	-	-	-	-	-	-
128	3	16	-	-	-	-	-	-
129	3	7	-	-	-	-	-	-
311	3	11	-	-	-	-	-	-
312	3	7	-	-	-	-	-	-
313	3	6	-	-	-	-	-	-

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
314	3	9	-	-	-	-	-	-
315	3	9	-	-	-	-	-	-
316	3	18	-	-	-	-	-	-
317	3	12	-	-	-	-	-	-
318	3	6	-	-	-	-	-	-
319	3	2	-	-	-	-	-	-
321	3	17	-	-	-	-	-	-
322	3	13	-	-	-	-	-	-
323	3	2	-	-	-	-	-	-
324	3	11	-	-	-	-	-	-
325	3	1	-	-	-	-	-	-
326	3	4	-	-	-	-	-	-
327	3	6	-	-	-	-	-	-
328	3	8	-	-	-	-	-	-
329	3	4	-	-	-	-	-	-
331	3	6	-	-	-	-	-	-
332	3	2	-	-	-	-	-	-
333	3	13	-	-	-	-	-	-
334	3	10	-	-	-	-	-	-
335	3	1	-	-	-	-	-	-
336	3	1	-	-	-	-	-	-
337	3	1	-	-	-	-	-	-
341	3	10	-	-	-	-	-	-
342	3	3	-	-	-	-	-	-
343	3	4	-	-	-	-	-	-
344	3	51	0.840	0.001	0.341	0.970	8	0.922
345	3	1	-	-	-	-	-	-
346	3	2	-	-	-	-	-	-
347	3	8	-	-	-	-	-	-
348	3	2	-	-	-	-	-	-
349	3	1	-	-	-	-	-	-
351	3	224	0.988	0.001	0.974	1.000	9	0.653
352	3	11	-	-	-	-	-	-
361	3	2	-	-	-	-	-	-
362	3	1	-	-	-	-	-	-
363	3	18	-	-	-	-	-	-
364	3	16	-	-	-	-	-	-
365	3	3	-	-	-	-	-	-
366	3	6	-	-	-	-	-	-
367	3	3	-	-	-	-	-	-
371	3	5	-	-	-	-	-	-
372	3	4	-	-	-	-	-	-
373	3	5	-	-	-	-	-	-
374	3	11	-	-	-	-	-	-
375	3	9	-	-	-	-	-	-
376	3	13	-	-	-	-	-	-
377	3	5	-	-	-	-	-	-
378	3	7	-	-	-	-	-	-
379	3	7	-	-	-	-	-	-
381	3	12	-	-	-	-	-	-

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
382	3	7	-	-	-	-	-	-
383	3	2	-	-	-	-	-	-
384	3	3	-	-	-	-	-	-
391	3	17	-	-	-	-	-	-
392	3	2	-	-	-	-	-	-
393	3	3	-	-	-	-	-	-
394	3	3	-	-	-	-	-	-
395	3	2	-	-	-	-	-	-
396	3	5	-	-	-	-	-	-
397	3	5	-	-	-	-	-	-
398	3	2	-	-	-	-	-	-

Figure 14370-1. 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 14370-2) and stratified sampling of individuals within the breeding range (Figure 14370-3) and the non breeding range (Figure 14370-4). 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.
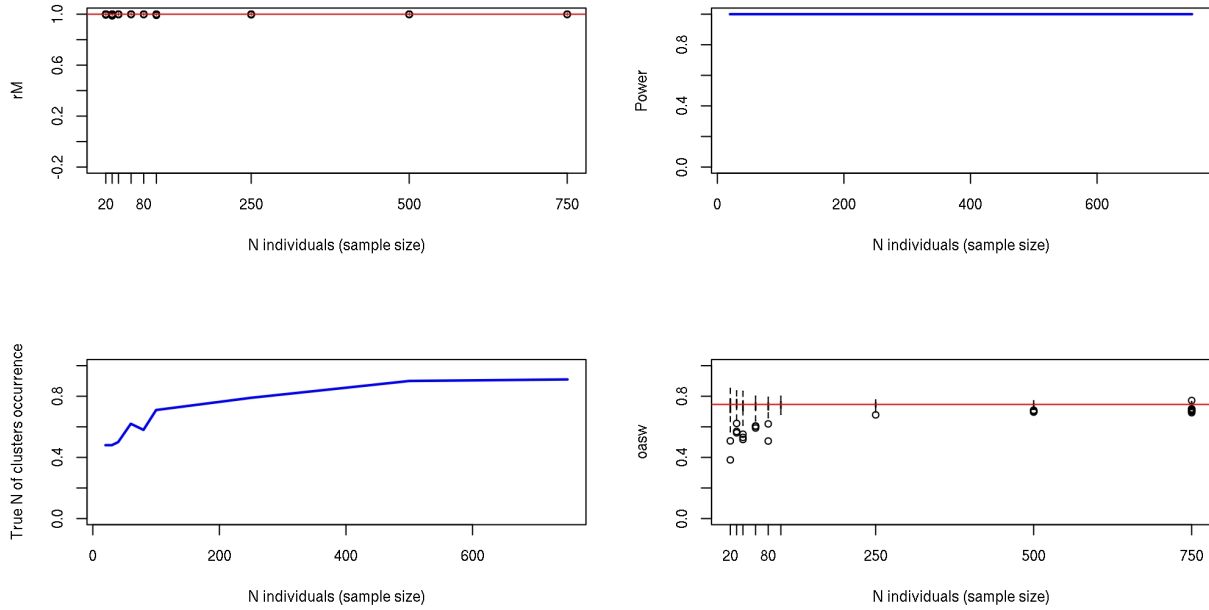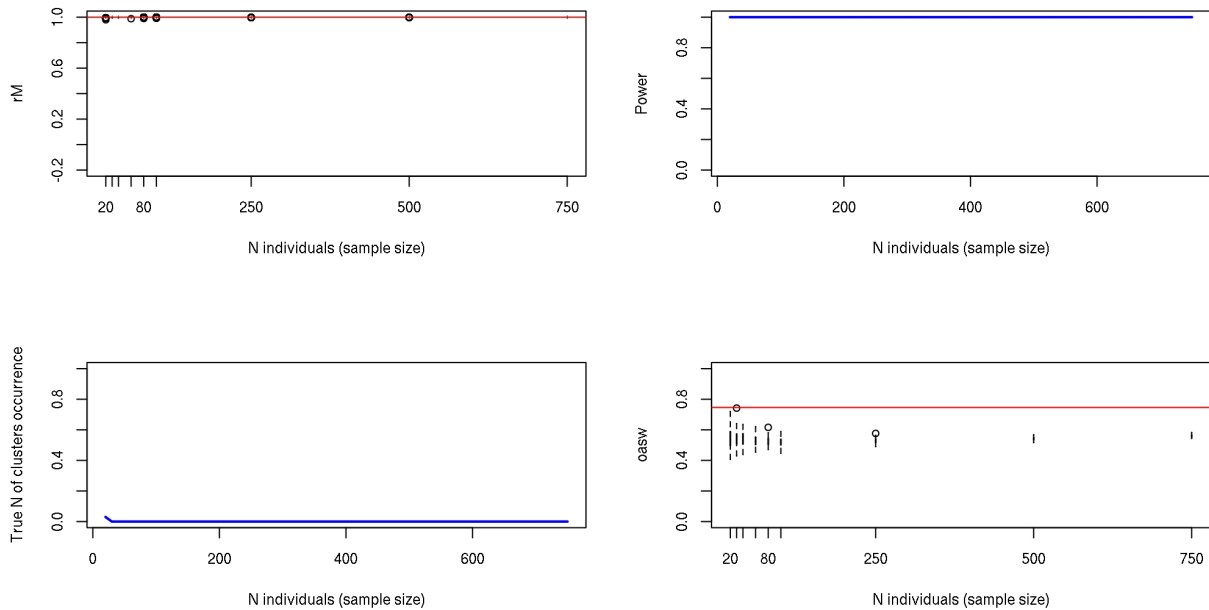

Figure 14370-2. Top left: simulated distribution (boxplots) and observed value (red line) of connectivity. Top right: Simulated power of the analysis (i.e. proportion of times the analyses on the subset of individuals was significant). Bottom left: Proportion of times the analysis provides the observed best number of cluster. Bottom right: simulated distribution (boxplots) and observed value (red line) of clustering intensity.
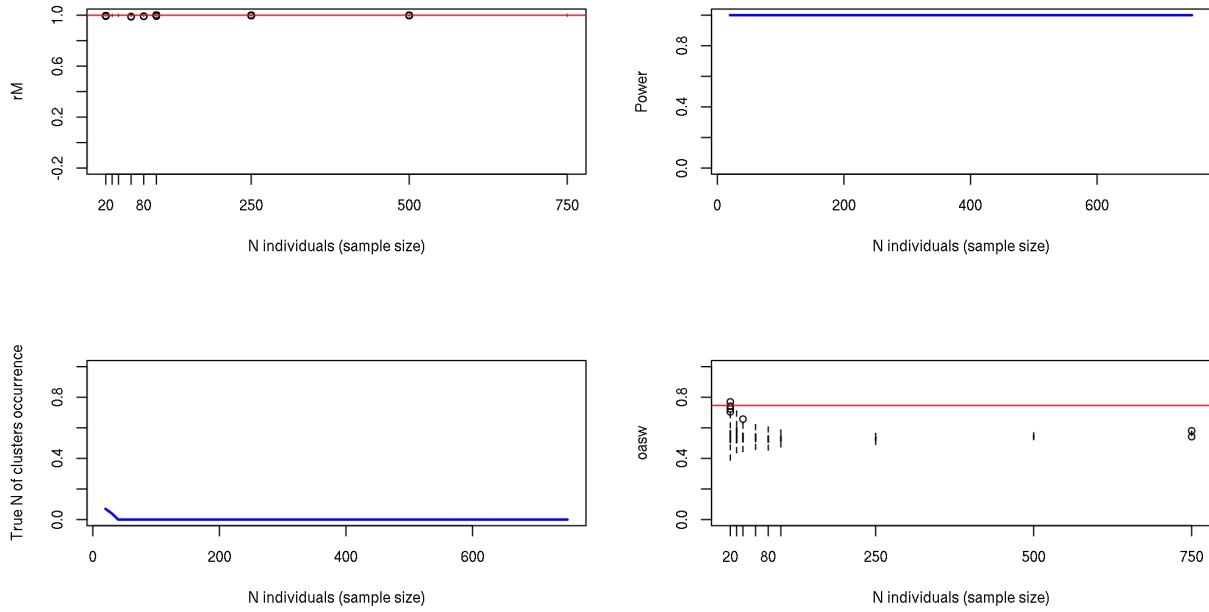

Figure 14370-3. Top left: simulated distribution (boxplots) and observed value (red line) of connectivity. Top right: Simulated power of the analysis. Bottom left: Proportion of times the analysis provides the

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

Figure 14370-4. 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 14370-5).
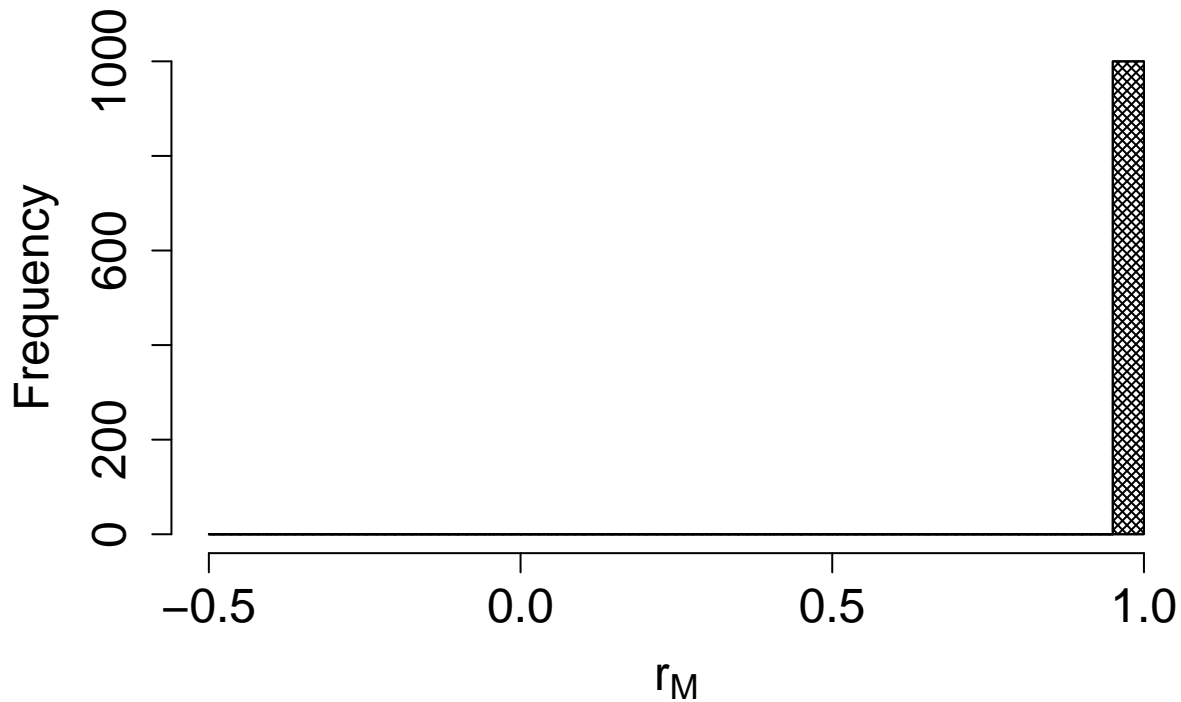
Figure 14370-5. Comparison between the bootstrapped distributions of connectivity value for alive recaptures (filling lines with angle=45°) and dead recoveries (filling lines with angle=375°).

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 14370-2; Figure 14370-6).

Table 14370-2. 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	1268080	Central Europe	0.997
Central Europe	1268080	West Europe	0.003
East Europe	3925636	East Europe	1.000
North Europe	172400	North Europe	1.000
North-west Europe	874880	North-west Europe	1.000
South-central Europe	2313759	South-central Europe	1.000
South-east Europe	4515800	South-east Europe	1.000
South-west Europe	9099420	South-west Europe	1.000
West Europe	1058142	West Europe	1.000

Figure 14370-6. 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.