

SUPPLEMENTARY MATERIAL

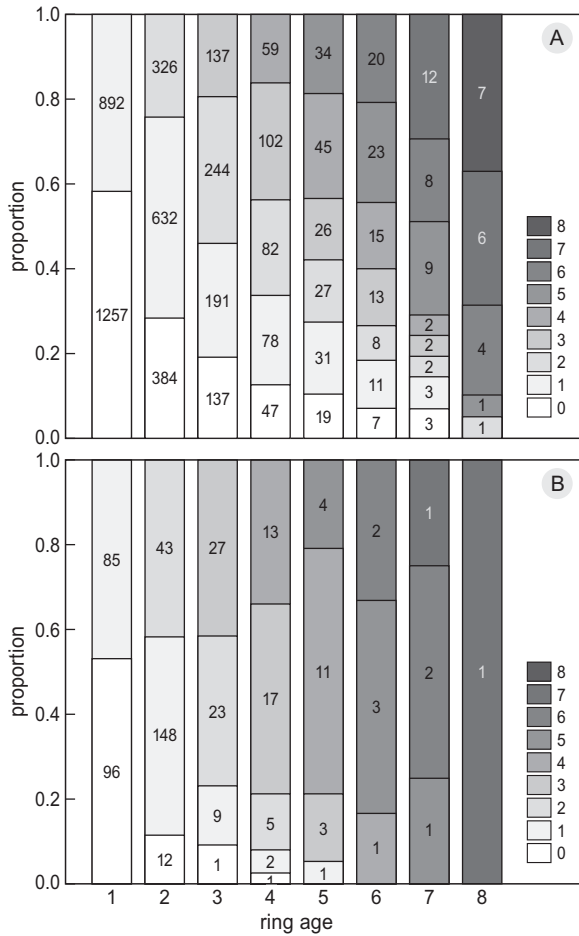


Figure S1. Proportion of (A) male and (B) female Ruffs absent for 0–8 years (shade of grey), by number of years after ringing (ring age). Sample size is given for each age.

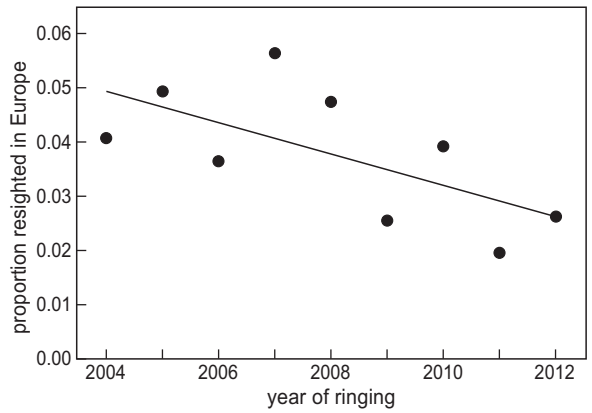


Figure S2. Proportion of male individuals known to have wintered in Europe (resighted in Europe at least once in October–December 2004–2019), by year of ringing (in March–May).

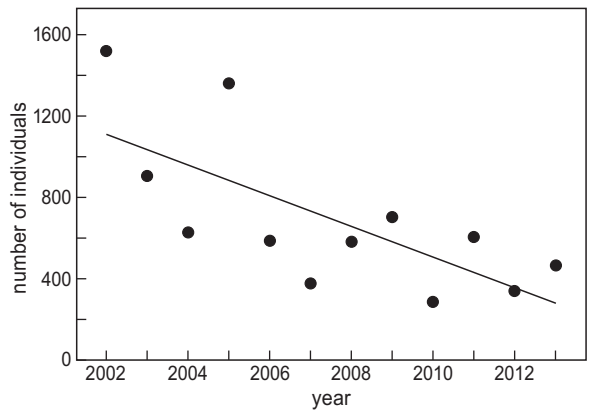


Figure S3. Maximum winter count of Ruffs in The Netherlands. For each winter, the maximum monthly count in October–December was selected (Sovon waterbird monitoring reports available at www.sovon.nl/nl/monitoringrapporten).

Table S1. Arrival (date of first observation) of staging male Ruffs. Analysis assuming that arrival dates follow a single normal distribution or a mix of two normal distributions (see Methods for details).

Wintering area	Year	<i>n</i>	<i>P</i> -value*		One normal distribution		Two normal distributions						normalmixEM trials [†]
							Peak 1			Peak 2			
			<i>k</i> = 1	<i>k</i> = 2	Mean	SD	Mean	SD	λ	Mean	SD	λ	
All	2006	193	0.3		92.4	9.3	89.8	7.5	0.85	106.7	4.3	0.15	268 / 268
All	2007	184	0.3		91.5	9.8	70.0	3.0	0.06	92.9	8.4	0.94	300 / 0
All	2008	190	0.8		86.9	10.3	61.3	0.44	0.04	87.8	9.2	0.96	26 / 0
All	2009	159	0.0	0.02	81.2	9.9	80.1	7.8	0.97	115.4	2.2	0.03	35 / 313
All	2010	165	0.2		87.1	11.2	84.5	9.1	0.88	106.5	4.8	0.12	952 / 952
All	2011	176	0.8		84.2	9.9	82.0	7.7	0.89	101.8	8.3	0.11	796 / 910
All	2012	202	0.0	0.1	81.0	9.0	76.7	5.4	0.63	88.4	9.2	0.37	992 / 992
All	2013	154	0.8		89.0	11.4	81.5	8.5	0.58	99.1	5.5	0.42	870 / 870

n: number of different individuals. λ : mixing proportion, indicates the proportion of individuals belonging to each distribution. *the *P*-value was calculated with the boot.comp function in mixtools, testing the null hypothesis of a *k*-component fit versus the alternative (*k*+1).

Table S2. Departure (date of last observation) of staging male Ruffs. Analysis assuming that departure dates follow a single normal distribution or a mixture of two normal distributions (see Methods for details).

Wintering area	Year	<i>n</i>	<i>P</i> -value*		One normal distribution		Two normal distributions						normalmixEM trials [†]
							Peak 1			Peak 2			
			<i>k</i> = 1	<i>k</i> = 2	Mean	SD	Mean	SD	λ	Mean	SD	λ	
All	2006	193	0.4		108.5	10.3	90.7	4.9	0.10	110.5	8.7	0.90	824 / 824
All	2007	184	0.1		107.0	10.4	103.1	9.0	0.74	118.0	4.6	0.26	794 / 794
All	2008	190	0.2		104.8	9.6	89.2	4.9	0.14	107.4	7.5	0.86	475 / 475
All	2009	159	0.0	0.6	97.7	11.8	84.7	2.4	0.22	101.3	10.8	0.78	944 / 999
All	2010	165	0.02	0.4	105.7	9.6	90.2	4.9	0.17	108.8	6.8	0.83	365 / 990
All	2011	176	0.2		104.1	10.7	100.7	9.5	0.77	115.8	4.4	0.23	768 / 876
All	2012	202	0.0	0.09	101.1	11.0	92.4	8.6	0.49	109.3	5.2	0.51	584 / 844
All	2013	154	0.05	0.6	106.3	10.0	80.2	6.8	0.04	107.6	8.3	0.96	38 / 0

n: number of different individuals. λ : mixing proportion, indicates the proportion of individuals belonging to each distribution. *the *P*-value was calculated with the boot.comp function in mixtools, testing the null hypothesis of a *k*-component fit versus the alternative (*k*+1).

Table S3. Date of observation of transient Ruffs. Analysis assuming that departure dates follow a single normal distribution or a mixture of two normal distributions (see Methods for details).

Wintering area	Year	<i>n</i>	<i>P</i> -value*		One normal distribution		Two normal distributions						normalmixEM trials [†]
							Peak 1			Peak 2			
			<i>k</i> = 1	<i>k</i> = 2	Mean	SD	Mean	SD	λ	Mean	SD	λ	
All	2006	212	0.0	0.4	99.3	11.2	91.5	6.7	0.58	107.0	3.5	0.33	124 / 174
All	2007	219	0.05		97.7	13.7	96.8	13.0	0.97	124.3	0.5	0.03	658 / 0
All	2008	242	0.2		95.7	12.1	89.5	9.6	0.65	107.3	6.3	0.35	679 / 679
All	2009	186	0.0	0.2	92.3	12.2	84.3	6.4	0.59	103.9	8.7	0.41	533 / 587
All	2010	203	0.0	0.04	96.0	11.3	88.9	7.1	0.63	107.9	5.3	0.37	655 / 950
All	2011	169	0.03	0.2	95.0	12.8	87.7	8.9	0.64	108.0	6.8	0.36	689 / 689
All	2012	183	0.007	0.3	92.1	12.3	86.6	8.8	0.74	108.1	5.1	0.26	790 / 790
All	2013	103	0.009	0.2	98.8	13.8	76.1	5.6	0.19	104.0	9.1	0.81	510 / 978

n: number of different individuals. λ : mixing proportion, indicates the proportion of individuals belonging to each distribution. *the *P*-value was calculated with the boot.comp function in mixtools, testing the null hypothesis of a *k*-component fit versus the alternative (*k*+1).

Table S4. Proportion of males wintering in Europe resighted by country.

Country	Proportion	Number
Belgium	0.210	45
France	0.019	4
Germany	0.014	3
Portugal	0.042	9
Spain	0.051	11
The Netherlands	0.547	117
United Kingdom	0.117	25

Table S5. Date of arrival of staging males, by number of seasons since ringing (ring age).

Ring age	Number	Median	Mean \pm SD
1	601	87	87.7 \pm 10.9
2	406	87	87.2 \pm 10.7
3	210	83	85.2 \pm 11.1
4	109	82	84.2 \pm 10.1
5	55	83	82.7 \pm 11.2
6	29	85	85.1 \pm 10.1

Table S6. Date of departure of staging male Ruffs, by number of seasons since ringing (ring age).

Ring age	Number	Median	Mean \pm SD
1	601	106	104.6 \pm 11.1
2	406	107	105.4 \pm 10.5
3	210	105	103.9 \pm 11.5
4	109	104	102.5 \pm 9.8
5	55	104	102.8 \pm 11.7
6	29	106	104.9 \pm 9.9

Table S7. Minimal stopover duration of staging Ruffs.

Sex	Wintering area	Year	Median	Mean \pm SD
all	all	all	16	17.8 \pm 12.1
female	all	all	14	16.1 \pm 13.3
male	Europe	all	19	20.4 \pm 12.4
male	mixed	all	15	17.3 \pm 11.9
male	all	2006	15	16.1 \pm 11.5
male	all	2007	14	15.5 \pm 11.2
male	all	2008	16	17.9 \pm 11.5
male	all	2009	15	16.5 \pm 12.4
male	all	2010	16	18.6 \pm 12.5
male	all	2011	19	19.9 \pm 11.8
male	all	2012	18	19.9 \pm 11.9
male	all	2013	14	17.4 \pm 13.5

Table S8. Minimal stopover duration of adult males by number of seasons since ringing (ring age).

Ring age	Number	Median	Mean \pm SD
1	601	15	16.9 \pm 11.5
2	406	16	18.2 \pm 12.1
3	210	16	18.7 \pm 13.1
4	109	17	18.3 \pm 11.8
5	55	19	20.1 \pm 13.2
6	29	19	19.7 \pm 12.1

Table S9. Repeatability of individual timing, including fixed effects year, ring age and wintering area.

Dependent variable	Sex	Class	Effect	R	CI	P
Resighted or not (N/Y)**	M	not seen & staging & transient	individual (n = 2157)	0.068 ± 0.006	0.039 – 0.060	<0.0001
			year, ring age, wintering area	0.014 ± 0.003	0.010 – 0.020	
Transient, staging (N/Y)**	M	staging & transient	individual (n = 629)	0.084 ± 0.013	0.041 – 0.089	<0.0001
			year, ring age, wintering area	0.019 ± 0.006	0.011 – 0.036	
Date of arrival [§]	M	staging & transient	individual (n = 629)	0.163 ± 0.027	0.109 – 0.217	<0.0001
			year, ring age, wintering area	0.055 ± 0.012	0.035 – 0.082	
	M	staging	individual (n = 488)	0.157 ± 0.043	0.077 – 0.243	<0.0001
			year, ring age, wintering area	0.067 ± 0.016	0.042 – 0.104	
	M	transient [#]	individual (n = 439)	0.136 ± 0.057	0.016 – 0.251	0.01
			year, ring age, wintering area	0.025 ± 0.012	0.009 – 0.057	
	F	transient [#]	individual (n = 25)	0.235 ± 0.161	0.000 – 0.573	0.1
			year, ring age, wintering area	0.117 ± 0.087	0.025 – 0.349	
Date of departure [§]	M	staging & transient	individual (n = 629)	0.204 ± 0.029	0.144 – 0.259	<0.0001
			year, ring age, wintering area	0.011 ± 0.005	0.004 – 0.025	
	M	staging	individual (n = 488)	0.172 ± 0.045	0.090 – 0.269	<0.0001
			year, ring age, wintering area	0.012 ± 0.008	0.003 – 0.032	
Minimal stopover duration [§]	M	staging & transient	individual (n = 629)	0.224 ± 0.028	0.171 – 0.279	<0.0001
			year, ring age, wintering area	0.035 ± 0.011	0.017 – 0.061	
	M	staging	individual (n = 488)	0.111 ± 0.043	0.030 – 0.200	<0.0001
			year, ring age, wintering area	0.022 ± 0.010	0.009 – 0.048	

R: Repeatability, SE: standard error, CI: confidence interval, N: number of different individuals included. [†]Resighted 2005–2019 (2006–2013 for the other variables). [§]LMM, including the setting 'adjusted=FALSE', which adds the variance explained by the fixed effects (year, ring age, sex, wintering area) to the denominator of the repeatability equation. [#]date of observation of transients: date of arrival and departure on the same day. *binomial GLMM, original-scale approximations shown.

Table S10. Comparison of presence and behaviour of male Ruffs marked 10 km north of the study area (Wommels) and in the study area. Individuals were marked in 2004–2012, and resighted in 2005–2019 in the study area. Data for 'behaviour' (type, arrival, departure, minimal stopover duration) are based on resightings from 2006–2013 only. Given are means and SD. n: sample size.

Variable	Wommels	Study area	Test
Total marked	451	4756	
Proportion resighted (n)	0.46 (204)	0.43 (2030)	Fisher's exact test: P = 0.3
Proportion staging (n)	0.36 (118)	0.48 (1425)	GLMM: z = -4.6, P < 0.0001
Arrival day – staging	88.9 ± 11.4	86.7 ± 10.9	LMM: $\chi^2_1 = 1.8, P = 0.2$
Departure day – staging	107.1 ± 10.8	104.4 ± 10.9	LMM: $\chi^2_1 = 4.1, P = 0.04$
Minimal stopover duration	18.2 ± 13.4	17.8 ± 12.1	LMM: $\chi^2_1 = 0.6, P = 0.4$
Date of transient visit	97.3 ± 12.1	95.8 ± 12.6	LMM: $\chi^2_1 = 0.02, P = 0.9$