Nightingale
Luscinia megarhynchos

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Range

The Nightingale breeds in NW Africa and from W Europe eastwards to the Crimea (Cramp, 1988). It is a long-distance migrant wintering in tropical Africa; European and NW African birds winter from W Africa east to Uganda and south of the Sahara to the rain forest belt (Cramp, 1988). Local breeding birds are present in all continental study sites except El Canal Vell, La Punta de la Banya and L'Alfacada, and on the islands only in the wet Balearics. Local birds are particularly common at Els Aiguamolls and wet Balearics, where they represent, respectively, *c.* 5% to 15% of all samples. At other sites with breeding populations the vast majority of captures, nevertheless, correspond to non-local migrants.

Migratory route

Recoveries indicate that birds migrate through the study area mostly in a NE direction, with an opposite axis of movement in autumn (Zink, 1973; Cramp, 1988; fig. 1). In the C Mediterranean birds return either SW-NE or follow a more due northerly route (Spina & Volponi, 2009). As suggested by Cramp (1988), spring migration apparently takes place further to the east than in autumn and some autumn recoveries in Morocco of birds ringed in Italy in spring strongly support this view (Spina & Volponi, 2009). Moreover, in Spain most autumn recoveries come from the west (Bueno, 1990). An interesting direct recovery is that of an adult (after second-year bird) ringed on L'Illa de l'Aire in early April and then retrapped in SW Spain, 947 km to the west, in late May; this bird apparently drifted towards the Balearic Islands and then reoriented itself towards its continental breeding grounds.

A good number of the recoveries detailed here are from Morocco, where the species is much more frequently recovered in spring than in autumn (Moroccan Bird Ringing Centre; unpubl. data), unlike the situation in Spain, where most recoveries are from autumn (Telleria et al., 1999). All this supports previous suggestions that birds stop in greater abundance in NW Africa in spring and in SW Europe in autumn (Zink, 1973; Cramp, 1988). The geographical variation of captures is difficult to interpret in this respect (fig. 2). The species is trapped in good numbers and frequencies at some sites in continental Spain, N Morocco and Els Columbrets/Balearics; however, variation is very high in all these areas. Apparently, birds move on a broad front through the area, as suggested also by a profusion of records from the N African coast and other Mediterranean islands (Spina et al., 1993; Cramp, 1988; Spina & Volponi, 2009); yet, captures at a given site depend to a large extent on very specific and local characteristics. In S Morocco, for example, we captured only one bird, but in other nearby sites other studies report much higher frequencies and numbers (Ash, 1969; Gargallo et al., unpubl.).

Phenology

Migration occurs from late March, rarely mid-March, to late May, with the main passage period occurring between early April and mid-May, peaking in mid-April (fig. 3). Some may still be on passage through Spain in early June (Finlayson, 1992; Telleria et al., 1999); late May captures in our sample certainly include a significant number of locally breeding birds. The overall pattern of passage is similar in N Morocco, Catalonia and on Els Columbrets/Balearics, and mirrors reports from elsewhere in N Morocco and Gibraltar (Finlayson, 1992; Thévenot et al., 2003). Migration timing through the C Mediterranean is rather similar, also peaking in mid-April in Italy (Spina et al., 1993) and Tunisia (Waldenström et al., 2004). In SE Morocco passage occurs somewhat earlier, mainly mid-March to late April or early May (Smith, 1968; Gargallo et al., unpubl.). In S Israel migration is distinctly earlier and peaks by early April (Morgan & Shirihai, 1997). Adults migrate clearly earlier than second-year birds, with median dates differing by 8 days (fig. 3).

Biometry and physical condition

Mean values for third primary lengths range from 62.7 in N Morocco to 64.6 in the wet Balearics (table 1), slightly lower than that obtained on the Tyrrhenian islands (mean 65.0, n = 605; Spina et al., 1993). Mean values for wing lengths vary from 81.2 (N Morocco) to 83.9 (Las Chafarinas), the maximum values being similar to those reported from S France, but slightly lower than from C and N Europe (Cramp, 1988) and much lower than those reported at Eilat in the E Mediterranean (Morgan & Shirihai, 1997). Birds from Morocco are the smallest, in accordance with the clinal variation observed in this species. Populations from N Africa and Iberia are reported to be smallest, with gradual increases in size towards the east (Cramp, 1988). The third primary length shows a significant tendency to decrease with time (fig. 6), in a similar way to that found in the C Mediterranean (Spina et al., 1993). This trend is at least in part due to differences in the timing of passage by the different sexes and age groups; larger males and adults pass earlier than females and second-year birds (see above; Cramp 1988).

Mean fat loads are rather low in general, ranging from 1.4 on Las Chafarinas to 2.7 in N Morocco (table 1), which are similar to values reported from the C Mediterranean (Spina et al., 1993). Figures are significantly greater in N Morocco and Catalonia than in the dry Balearics and on Els Columbrets. On the latter islands birds have the lowest average fat reserves. Physical condition averages are also significantly highest in N Morocco and the wet Balearics, and higher in Catalonia than in the dry Balearics; on Els Columbrets birds are in the worst condition (figs. 7-8). Fat decreases significantly with time in Catalonia and the wet Balearics (fig. 9) but physical condition increases in Catalonia, on Els Columbrets and in the dry Balearics (fig. 7). Mean body mass varies between 18.6 on Els Columbrets to 21.2 in the wet Balearics (table 1), but without showing any clear overall temporal trend. It decreases significantly in N Morocco but remains fairly constant in the Balearics and Catalonia (fig. 9). An overall temporal tendency to increase body mass has been reported in the C Mediterranean (Spina et al., 1993).

Body mass parallels geographical differences observed in fat and physical condition (table 1). In N Morocco and Catalonia birds are distinctly heavier than on Els Columbrets and in the dry Balearics; those from N Morocco are not significantly heavier than in Catalonia due to their smaller size (their physical condition being significantly better). In the wet Balearics birds have the highest average body mass, probably due to a high proportion of local breeding birds and the largest overall size. Averages on Els Columbrets and in the dry Balearics are similar to those recorded on the Tyrrhenian islands (mean 19.2, n = 608; Spina et al., 1993), but lower than on Malta (mean 21.8, n = 50; Cramp, 1988). Body mass in spring migrants from S France and S England is similar or slightly higher than that given here for Catalonia (means 20.1 [n = 15] and 21.4 [n = 15], respectively; Cramp, 1988). Averages from N Morocco are similar to those reported from S Iberian Peninsula (mean 19.9, n = 37; Finlayson, 1981; Cramp 1988), but slightly lower than in N Tunisia (mean 21.1, n = 110; Waldenström et al., 2004) due to the distinctly larger size of birds trapped there (physical condition is even better in N Morocco). Data from S Morocco are too scarce (only one bird trapped), although information gathered at nearby sites shows that the average body mass in the area ranges between 18.3 (n = 276; Ash, 1969) and 20.2 (n = 411; Gargallo et al., unpubl.), 0-10% lower than in N Morocco.

Stopover

Nightingales tend to stopover in greater abundance in N Morocco and Catalonia (c. 20% of retraps) and in both areas are able to increase in mass during their stay thanks to positive fuel deposition rates (the rate is identical in Catalonia when only using data from El Canal Vell, where no breeding birds are present; fig. 5, table 2). On Els Columbrets and in the dry Balearics birds that remain in the area are in poorer body condition when first captured than those passing through, and in both areas birds show significant negative fuel deposition rates (in the dry Balearics only when considering all retraps). The average stopover length is highest in Catalonia and the wet Balearics, where apparently a higher proportion of local breeding birds are included since when only using data from El Canal Vell the mean stopover length is much lower (2.35, n = 20).

As suggested by biometrical data, these results indicate that birds are able to gain fat in Morocco, although not to any great extent, and that they can regain some of the mass lost during migration while passing through continental S Europe. In fact, as suggested by the minor differences between body mass in N Morocco, Catalonia and more northern Europe (see above), the species seem to move through the continent largely using short bouts of flight and brief stopovers. Birds crossing through the Balearics/Els Columbrets have *c.* 10% worse physical condition than in N Morocco, but are unable to regain mass in the area. The fact that birds deciding to stay in the dry Balearics and, particularly, on Els Columbrets tend to be in poorer body condition and undergo negative fuel deposition rates indicates these islands' function as precarious stopover sites.

Table 1. Mean (± SD), range and sample size of main biometric parameters according to area.

	n	Wing	Third primary	Body mass	Fat score
Catalonia	1,615	82.6 ± 2.3 (76.0-90.5)	63.7 ± 2.1 (56.0-71.0)	20.0 ± 1.7 (12.2-32.4)	1.9 ± 1.3 (0-7)
Columbrets	1,174	82.4 ± 2.5 (72.0-91.0)	63.0 ± 2.2 (54.5-70.0)	18.6 ± 2.2 (11.4-32.0)	1.7 ± 1.2 (0-7)
Balearics (dry)	1,915	82.9 ± 2.6 (73.5-91.0)	64.0 ± 2.4 (54.0-71.0)	19.5 ± 2.3 (12.0-29.4)	2.2 ± 1.4 (0-7)
Balearics (wet)	84	83.8 ± 2.2 (78.0-88.5)	64.6 ± 2.0 (60.5-68.5)	21.1 ± 1.8 (17.8-27.6)	2.2 ± 1.3 (0-6)
Chafarinas	14		62.7 ± 2.4 (59.5-68.5)	19.4 ± 1.5 (16.3-21.9)	1.4 ± 1.0 (0-3)
N Morocco	244	81.2 ± 2.6 (72.5-89.0)	62.7 ± 2.1 (55.5-68.0)	20.3 ± 2.7 (11.5-28.3)	2.7 ± 1.5 (0-8)
S Morocco	1	82.0	63.0	19.2	2.0

Table 2. Variation in fuel deposition rate (g/day) according to area and type of retraps involved (mean ± 95% CI and sample size are given).

	Catalonia	Columbrets	Balearics (dry)	Balearics (wet)	Chafarinas	N Morocco
All retraps	0.08 ± 0.07 (299)	-0.63 ± 0.33 (26)	-0.22 ± 0.12 (163)	-0.18 ± 0.45 (9)		0.28 ± 0.19 (51)
Retraps >1 day	0.12 ± 0.04 (241)	-0.20 ± 0.19 (15)	-0.05 ± 0.11 (86)	0.01 ± 0.28 (8)		0.30 ± 0.17 (39)

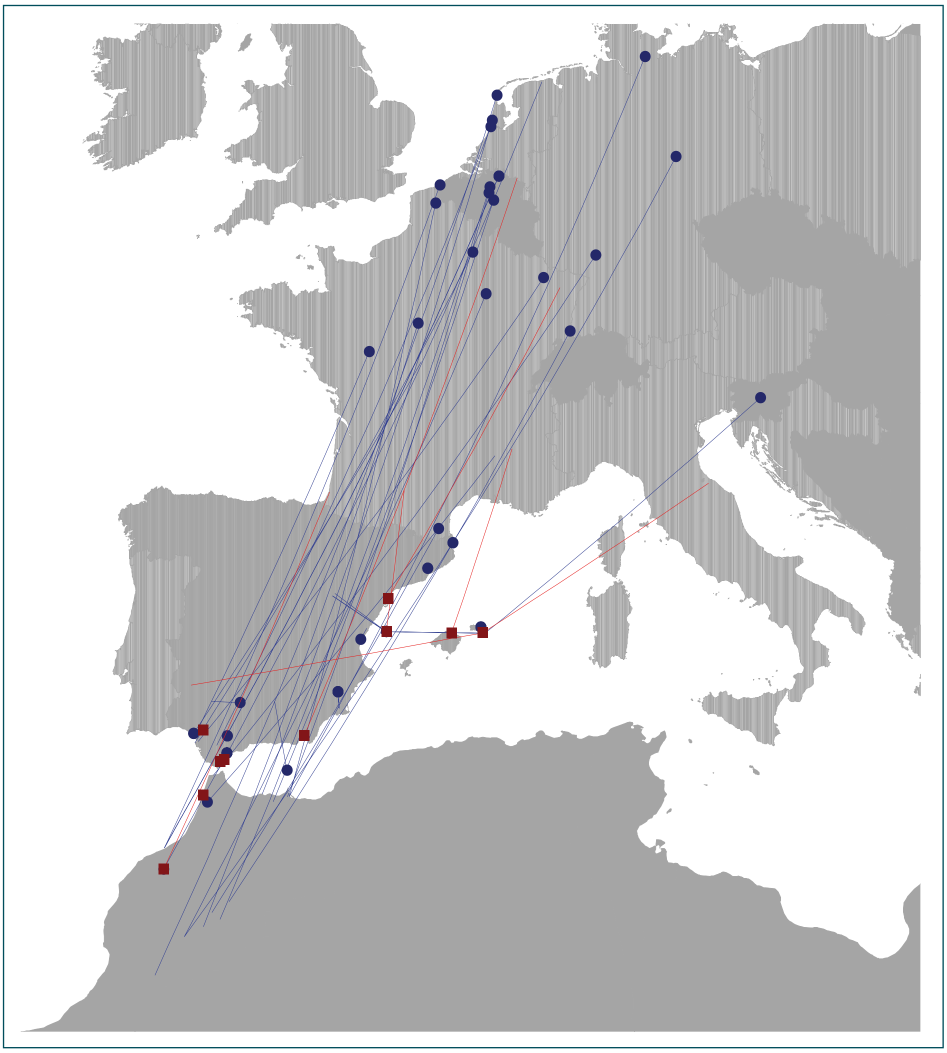


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

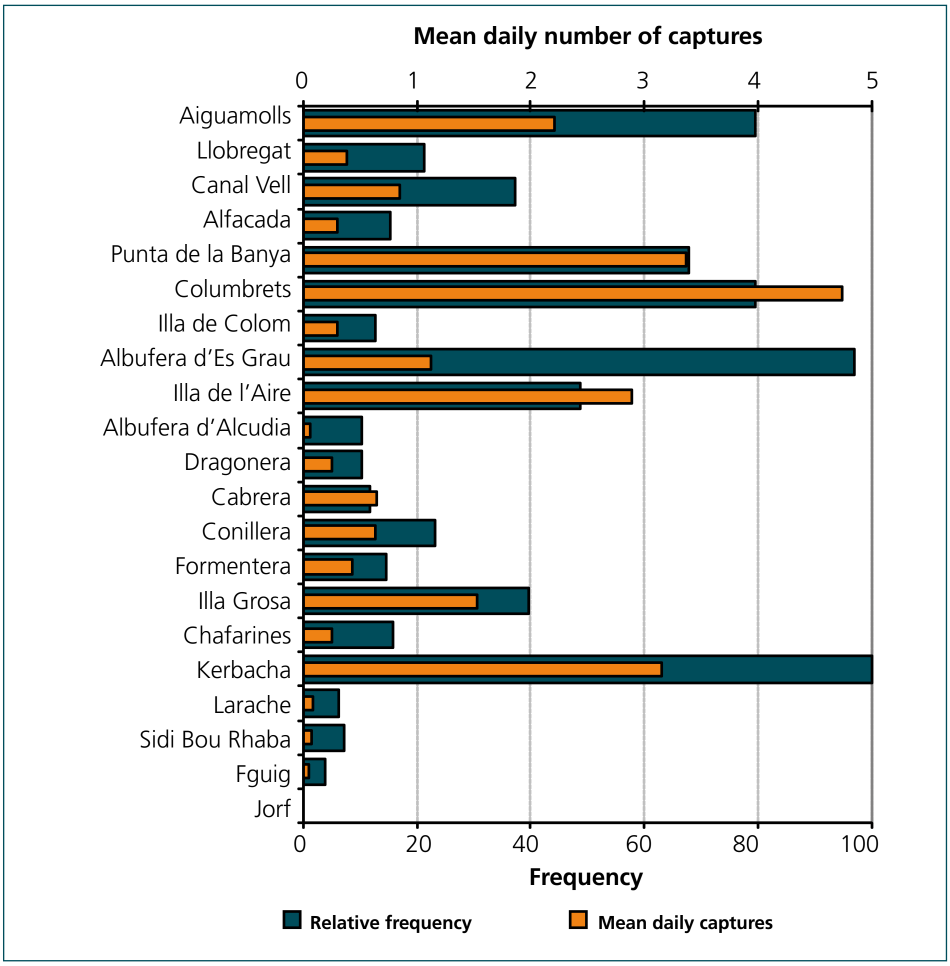


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

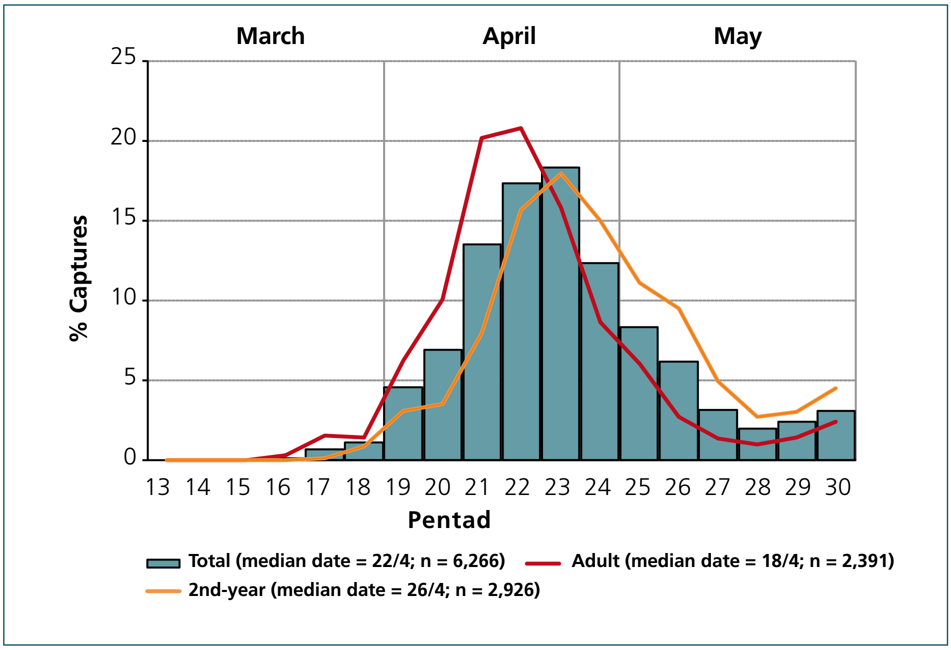


Figure 3. Frequency of captures during the study period.

Figure 4. Variation in body mass and fat score according to site during the standard period (16 April to 15 May).

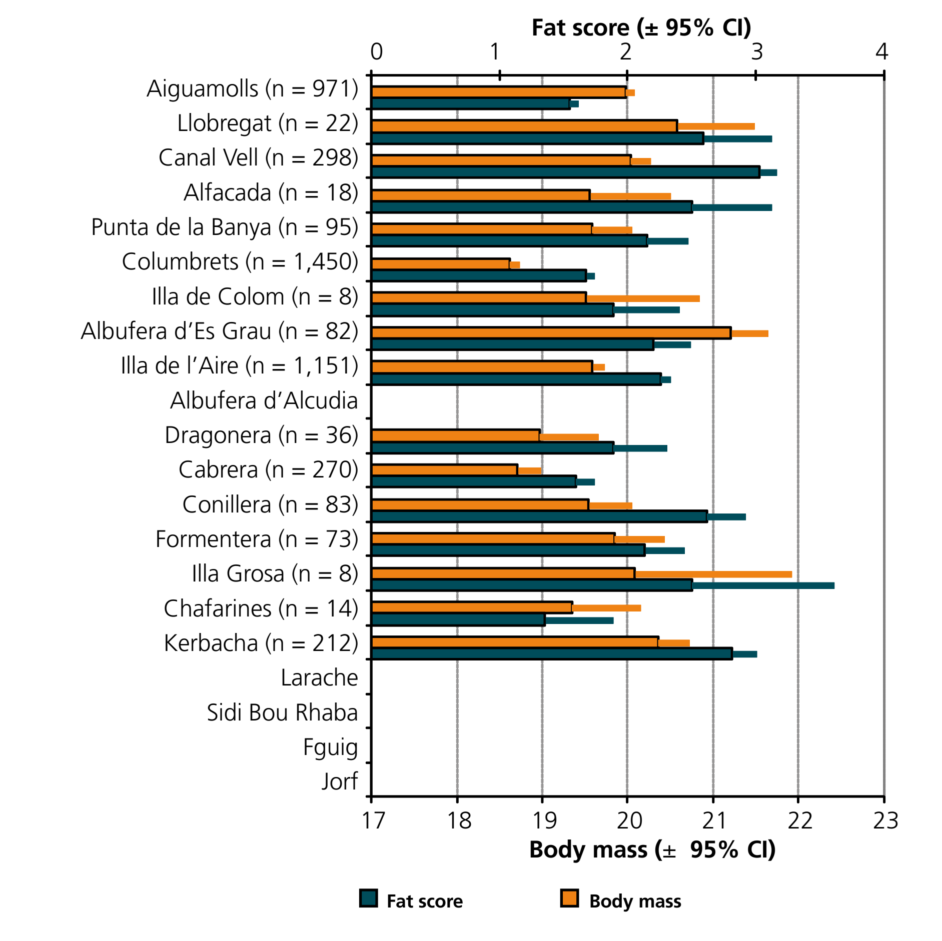
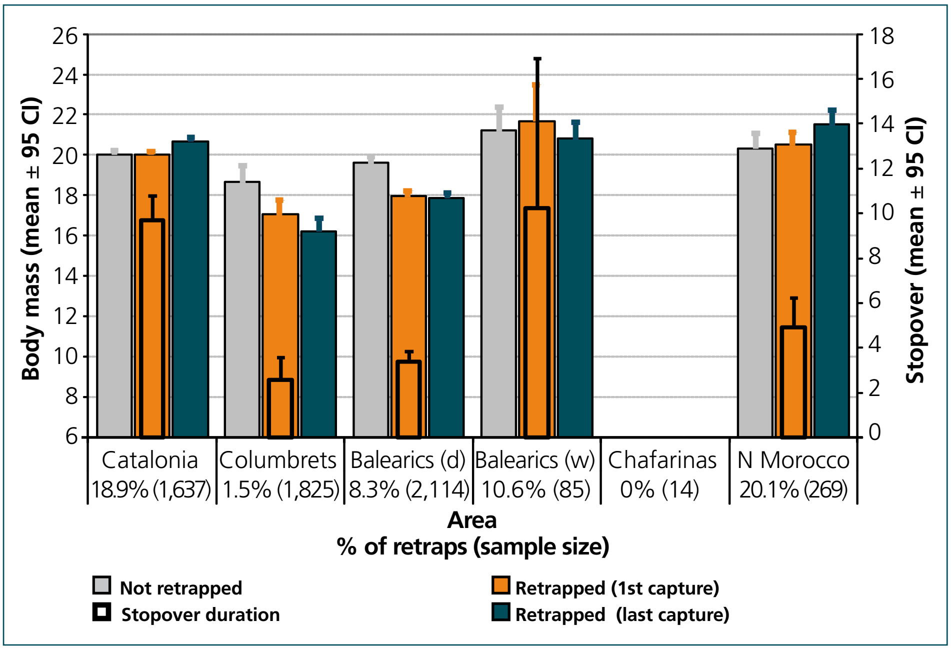


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



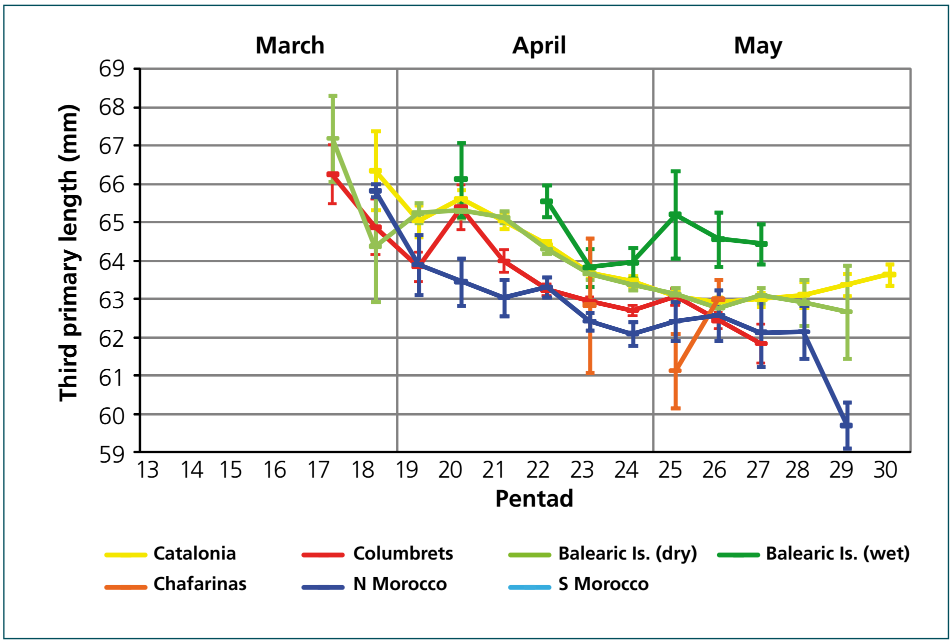


Figure 6. Temporal variation of third primary length according to area.

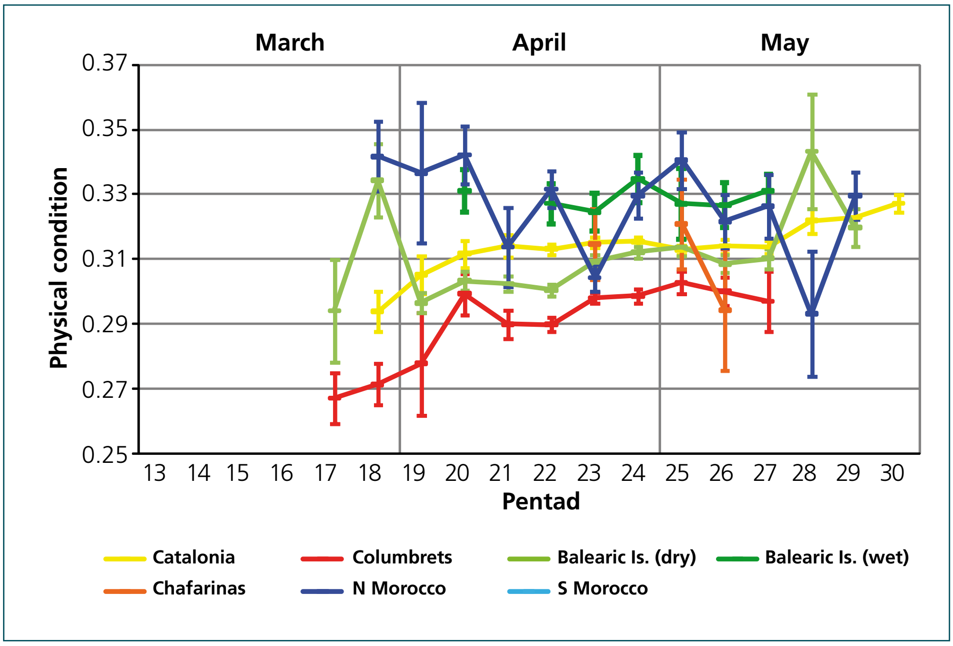


Figure 7. Temporal variation of physical condition according to area.

Figure 8. Temporal variation in body mass according to area.

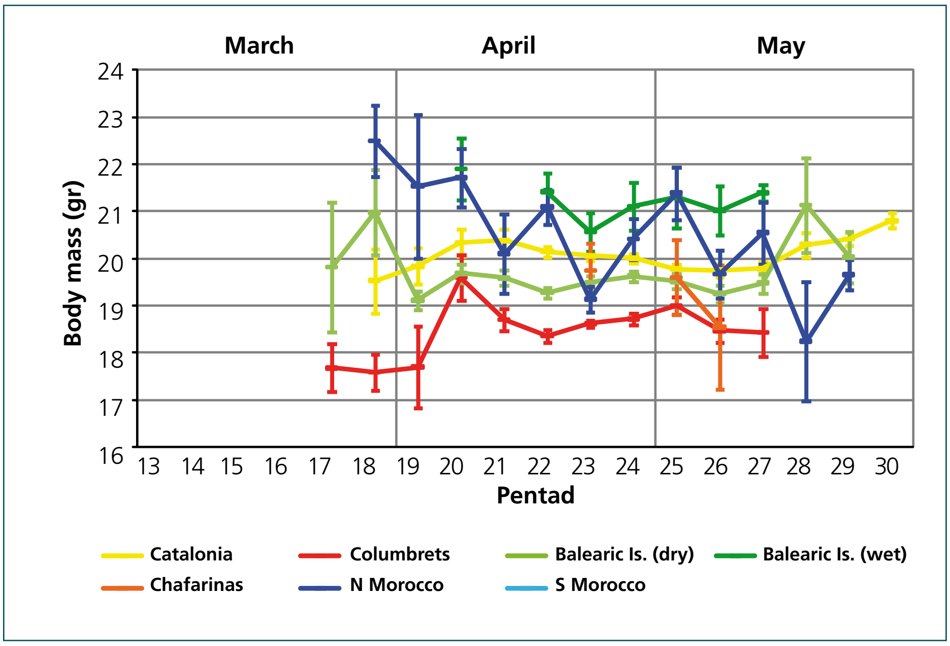


Figure 9. Temporal variation in fat score according to area.