Spotted Flycatcher *Muscicapa striata*

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Range

The Spotted Flycatcher breeds in coastal NW Africa, most of Europe and eastwards to C Asia (Cramp, 1998). Several subspecies are recognized, although only two are present in the study area: the distinctly paler and smaller insular race *balearica*, endemic to the Balearic Islands (Gargallo, 1993), and the nominate race, which is distributed throughout most of continental Europe (Cramp, 1998). All populations are migratory, wintering in sub-Saharan Africa mostly south of the equator to the extreme tip of S Africa (Cramp, 1998); a few exceptional winter records from the Mediterranean region exist (Telleria et al., 1999). This flycatcher is a widespread breeder in the study area, but generally not at the specific ringing sites and local breeding birds are only occasionally trapped in the wet Balearics and on Formentera.

Migratory route

Recoveries indicate migration is mostly undertaken in a NNE or NE direction, the opposite to movement in autumn (Cramp, 1998; fig. 1). A good number of birds, however, return in more direct N or NNW directions (Zink, 1975; Cramp, 1998; Wernham et al., 2002), as indicated by the recovery of birds originating from Britain. All available recoveries suggest origins west of *c.* 12ºE, in accordance with the migratory divide shown in autumn (Zink, 1975). Two direct recoveries show interesting migratory patterns: a bird was ringed on L'Illa de l'Aire and recovered a day later on Formentera 263 km to the SW; another bird was ringed on Els Columbrets and recovered 11 days later on Dragonera in the Balearics, 145 km to the ESE. Both cases seem to involve birds of race *balearica* undertaking reverse movements towards breeding areas, having overshot during migration across the sea.

Nearly all birds trapped in Catalonia and Morocco belong to the nominate race, while in the Balearics approximately half of the birds are *striata* and the other half *balearica*. Some *balearica* are also trapped on Els Columbrets, although the exact quantitative data regarding racial composition is unknown since only a few birds were identified to subspecies level. However, a similar average third primary length to the dry Balearics (see below) suggests that the insular race is also common on Els Columbrets (*balearica* has distinctly shorter wings; Gargallo, 1993; table 1). At Catalan ringing sites *balearica* is very rarely trapped. The race *tyrrhenica*, endemic to Corsica and Sardinia, may occur (probably in low numbers) in the Balearics, but so far no records have been reported.

Recoveries and geographical variation in the number of captures suggest that this species crosses the W Mediterranean on a broad front (present data;

Cramp, 1998). Most birds are trapped at insular sites, above all in the Balearics where both subspecies are equally common (fig. 2, table 1). Insular figures, however, appear to be over dimensioned due to a high attraction effect. This is clearly observed at the quasi-island of La Punta de la Banya, where birds are much more numerous than in the rest of the Ebro delta, but in distinctly poorer body condition (fig. 4). The species is more common in NW Africa in spring than in autumn (Fransson, 1986; Cramp, 1998; Thévenot et al., 2003), although at our specific study sites captures are rather scarce.

Phenology

Passage starts in mid-April, reaching a peak in early May and then decreasing steadily during the course of the month (fig. 3); some birds are still on passage during early June (*cf.* Telleria et al., 1999). Overall passage patterns in N Morocco, Catalonia and the Balearics/ Els Columbrets very similar. Passage of *balearica* takes place somewhat earlier than that of *striata* (median date 3 days earlier), these differences appearing greater (up to 10 days) when making direct comparisons in the Balearics due to the fact that *striata* migrates through these islands even later (fig. a). This is the reason why, in spite of marked differences in subspecific composition, overall passage patterns of the species in the islands do not differ from that observed in continental areas.

The overall pattern of passage of the species is similar to that reported in Gibraltar (Finlayson, 1992). The passage of race *striata* through S France occurs somewhat later (median 13 May in Camargue *vs.* 8 May in our continental dataset; Isenmann, 1989b). Similarly, it also occurs later on Capri in the C Mediterranean (Pettersson et al., 1990), in agreement with the higher proportion of birds of more northern origin and delayed breeding season passing through this area (Cramp, 1998; Spina & Volponi, 2009). In Morocco the earliest migrants arrive at the end of March in the south and by early April in the north, although, as shown by our data, usually not until mid-April (Thévenot et al., 2003).

Biometry and physical condition

Mean values for third primary lengths range from 64.6 on Els Columbrets to 67.4 in the wet Balearics (table 1). Mean values for wing lengths vary from 83.8 on Els Columbrets and the Balearic Islands to 87.1 in the wet Balearics and Catalonia. Geographical differences within the study area largely depend on differences in the relative abundance of shorter-winged *balearica* (see above). The mean third primary length in *striata* (continental birds and *striata* from Balearics) is slightly less than that reported in the Tyrrhenian islands (mean 68.2, n = 354; Spina et al., 1993), where the proportion of birds of more northern origin is higher (Spina & Volponi, 2009). Third primary length increases with time in the dry Balearics and Els Columbrets, reflecting the earliest passage of shorter-winged *balearica*. In fact, at the subspecific level, third primary decreases with time in both *striata* and *balearica*, though only significantly so in the former. Such pattern may reflect a differential passage of sexes, though size dimorphism in this species is at most very slight (Cramp, 1998). In the dry Balearics the distinctly short-winged birds in late May correspond to local breeding *balearica* birds (fig. 6).

Physical condition does not show clear overall temporal patterns, but increases significantly on Els Columbrets and in the Balaearics (fig. 7). Significant increases with time on Els Columbrets and in the dry Balearics in body mass (fig. 8) are certainly related to the differential passage of *striata* and *balearica*, but also occur within *balearica*. Fat scores also increase with time on Els Columbrets and in the Balearics in part due to differential racial passage, since *striata*, which has significantly higher fat reserves (table 1), migrates slightly later. In Catalonia (essentially *striata*) fat and body mass decrease with time, suggesting that birds passing earlier through the continent are in better overall condition.

Mean body mass varies from 12.1 on Els Columbrets to 14.5 in N Morocco, a degree of geographical variation largely determined by racial composition. Average body mass in Catalonia and the Balearics (*striata*) is very similar and only slightly lower than in N Morocco. These differences, however, are not detected in fat reserves. Body mass is significantly higher in the wet than in the dry Balearics (analysis limited to *striata*). Average figures from Catalonia and Balearics (*striata*) are similar to those reported from Gibraltar (mean 14.0, n = 20; Finlayson, 1981) and slightly higher than on the Tyrrhenian islands (mean 13.4, n = 355; Spina et al., 1993). Given the slightly larger size of birds passing through the C Mediterranean, these results from the Tyrrhenian islands suggest that birds migrating through this part of the Mediterranean are more energetically stressed (probably due to having crossed longer stretches of desert and sea). Average body mass in Catalonia is somewhat lower than in birds trapped further north in the Netherlands (mean 15.2, n = 9; Cramp, 1998) and S Sweden (mean 14.6, n = 67; Cramp, 1998). N Moroccan mean body mass is similar to that reported from N Tunisia (mean 14.3, n = 31; Waldenström et al., 2004) and *c.* 10% higher than in SE Morocco (mean 13.2, n = 37; Gargallo et al., unpubl.).

The biometrical data given here and the relative higher presence of the species in NW Africa in spring further corroborates previous views suggesting that this area is widely used to refuel (Cramp, 1998). However, body mass is only slightly lower in continental Spain and even somewhat higher in C and N Europe, suggesting that birds can regain some mass or even obtain net mass gains while migrating across continental Europe. It is curious that birds trapped in continental Spain are not in better condition than those migrating through the Balearics (*striata*), since the latter have already crossed *c.* 250-300 km of the Mediterranean Sea. This may reflect differences in departure-fat loads from NW Africa between birds migrating across the sea and those reaching Europe through SW Spain. On the other hand, *striata* from the wet Balearics are even heavier than on the other islands, suggesting that in these areas birds can refuel better or include a lower proportion of birds in poor condition needing to stop at the first available site.

Stopover

The percentage of retraps and stopover lengths are low in all areas (table 2, fig. 5). The higher percentage of retraps in the wet Balearics is partially overestimated due to local breeding birds. There are no significant differences in initial average body mass between retrapped and non-retrapped birds, although the latter tend to be heavier (except in the wet Balearics). Fuel deposition rates are positive in Catalonia (when not including one day retraps), while on Els Columbrets and in the dry Balearics the tendency is towards losing mass (all retraps) or to show no trend (no one-day retraps included). Data from the wet Balearics suggests positive rates there, but the sample is too small to be conclusive. Data is also insufficient for studying racial differences in stopover in the Balearics.

Overall, these results corroborate the scenario outline above, that is, this species can regain some mass along its continental European route and probably also at suitable insular habitats. The lack of retraps in N Morocco, however, suggests that fattening may already have taken place in nearby areas or other habitats rather than at the study sites.

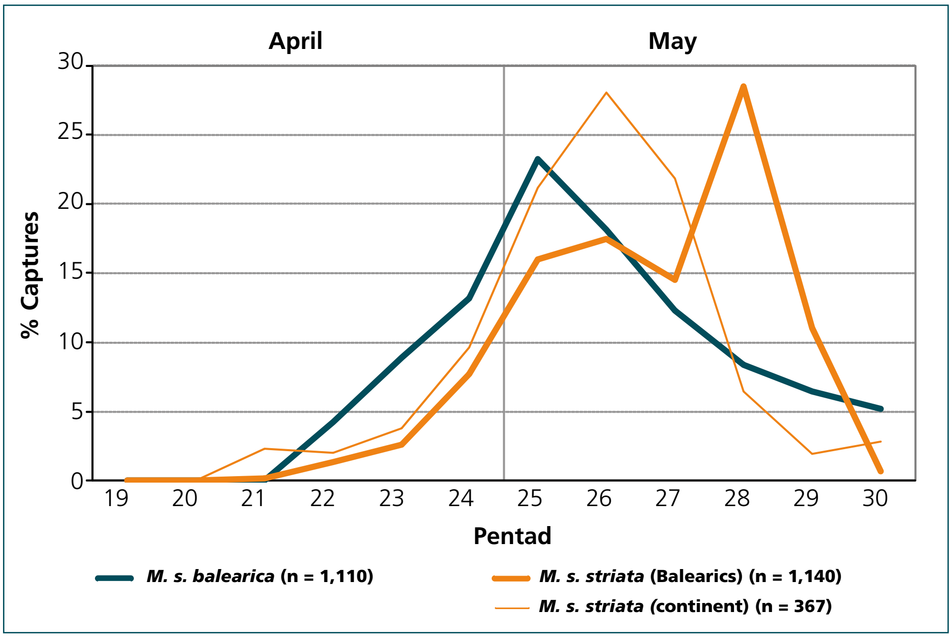


Figure a. Temporal variation in the frequency of captures of *M. s. striata* and *M. s. balearica*.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	257	87.1 ± 2.3 (79.0-92.0)	67.4 ± 2.1 (62.0-72.5)	13.8 ± 1.3 (9.7-17.8)	1.6 ± 1.0 (0-6)
Columbrets	834	83.8 ± 3.6 (75.5-96.0)	64.6 ± 2.7 (59.0-73.0)	12.1 ± 1.2 (7.5-17.6)	0.6 ± 0.6 (0-5)
Balearics (dry)	2,987	83.8 ± 3.5 (75.5-95.5)	64.9 ± 2.9 (56.5-73.0)	13.0 ± 1.5 (7.4-18.7)	1.3 ± 0.9 (0-5)
Balearics (wet)	25	87.1 ± 3.3 (79.0-91.5)	67.4 ± 3.0 (60.0-72.0)	14.3 ± 1.2 (11.9-16.4)	1.8 ± 0.8 (0-3)
Chafarinas	43		66.1 ± 1.9 (62.0-70.0)	13.3 ± 1.1 (11.5-16.5)	1.1 ± 0.8 (0-3)
N Morocco	35	85.8 ± 2.2 (81.5-91.0)	66.5 ± 1.8 (63.5-71.5)	14.5 ± 1.3 (12.2-18.0)	1.5 ± 1.0 (0-4)
S Morocco	0				
Balearics (dry) *striata*	1,056	86.5 ± 2.4 (77.0-95.5)	67.0 ± 2.2 (57.0-73.0)	13.7 ± 1.4 (7.4-18.3)	1.4 ± 0.9 (0-4)
Balearics (dry) *balearica*	1,056	81.0 ± 1.6 (76.0-87.0)	62.6 ± 1.6 (56.5-68.0)	12.2 ± 1.0 (8.9-17.6)	1.1 ± 0.7 (0-4)

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	-0.30 ± 0.44 (13)	-0.31 ± 0.29 (31)	-0.17 ± 0.15 (63)	0.40 ± 1.56 (3)	-0.17 ± 1.28 (2)	
Retraps > 1 day	0.49 ± 0.47 (4)	-0.23 ± 0.25 (16)	0.03 ± 0.13 (23)			

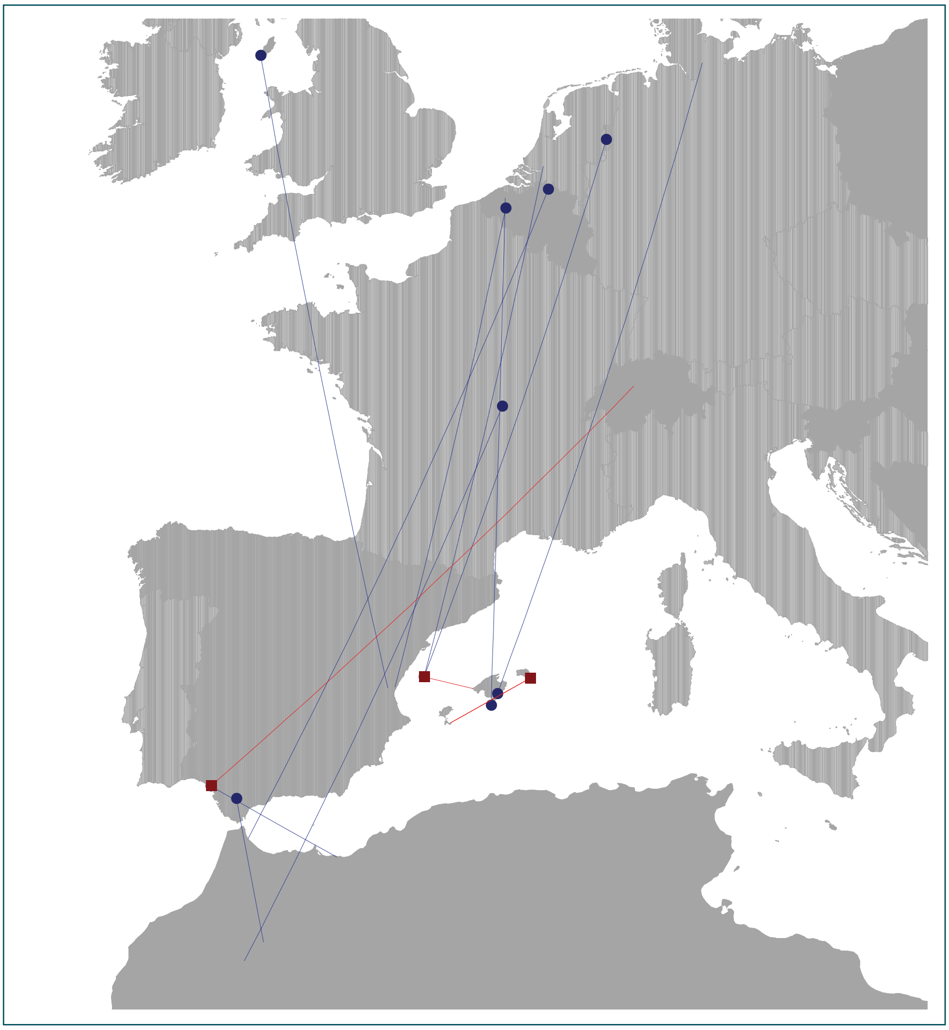


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

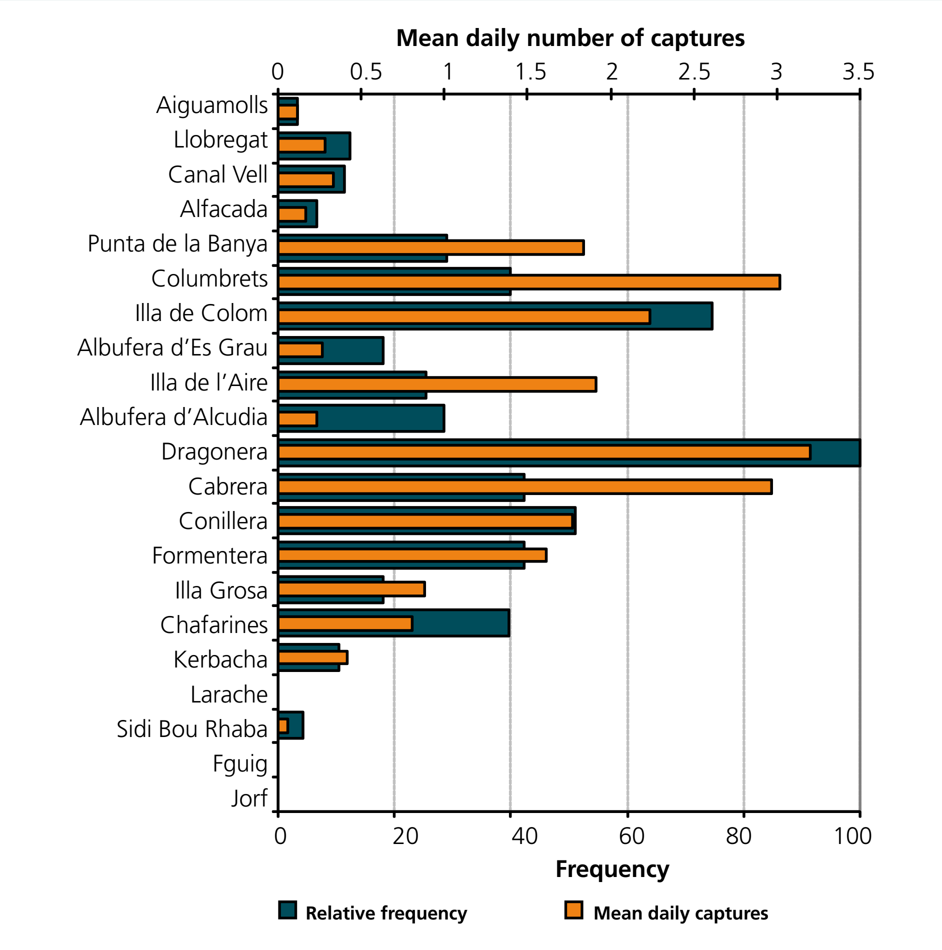


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

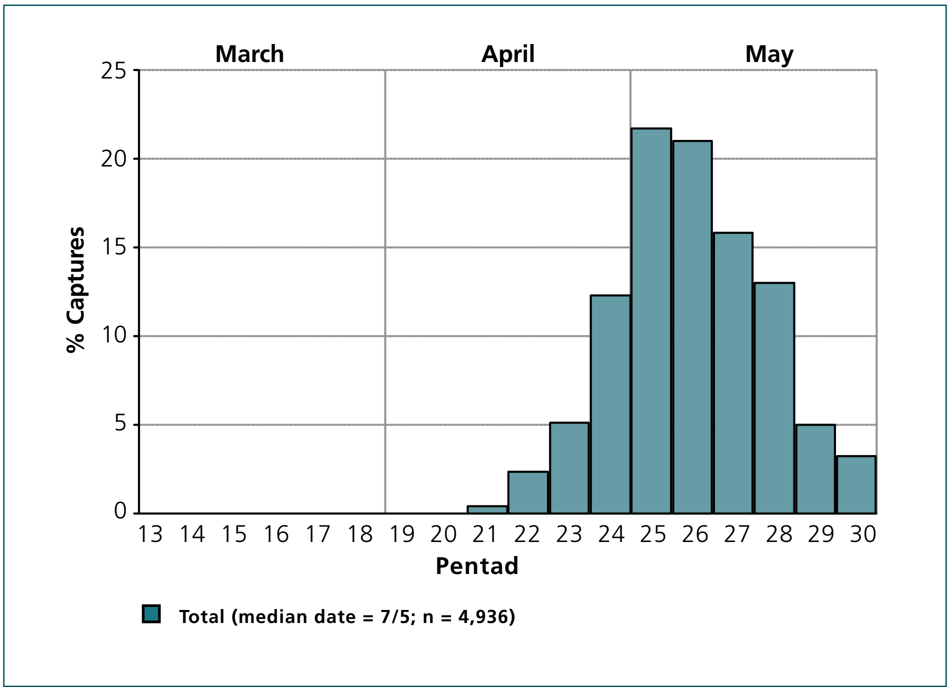


Figure 3. Frequency of captures during the study period.

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

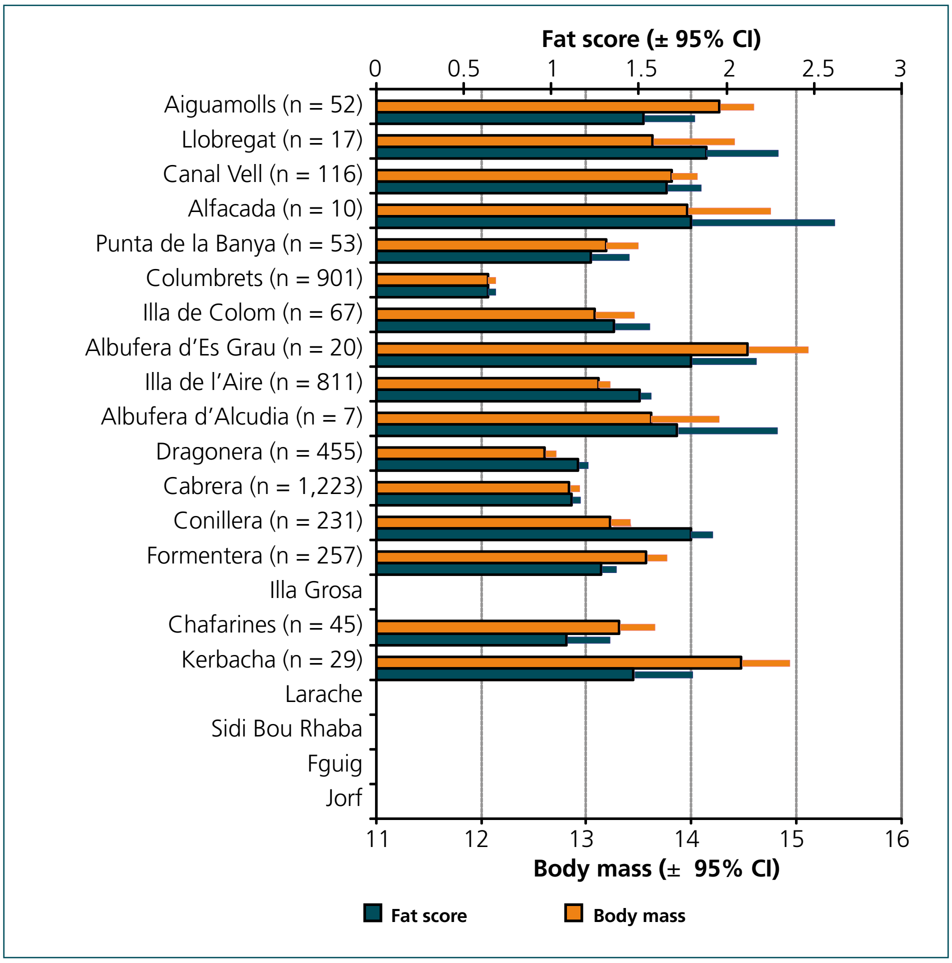
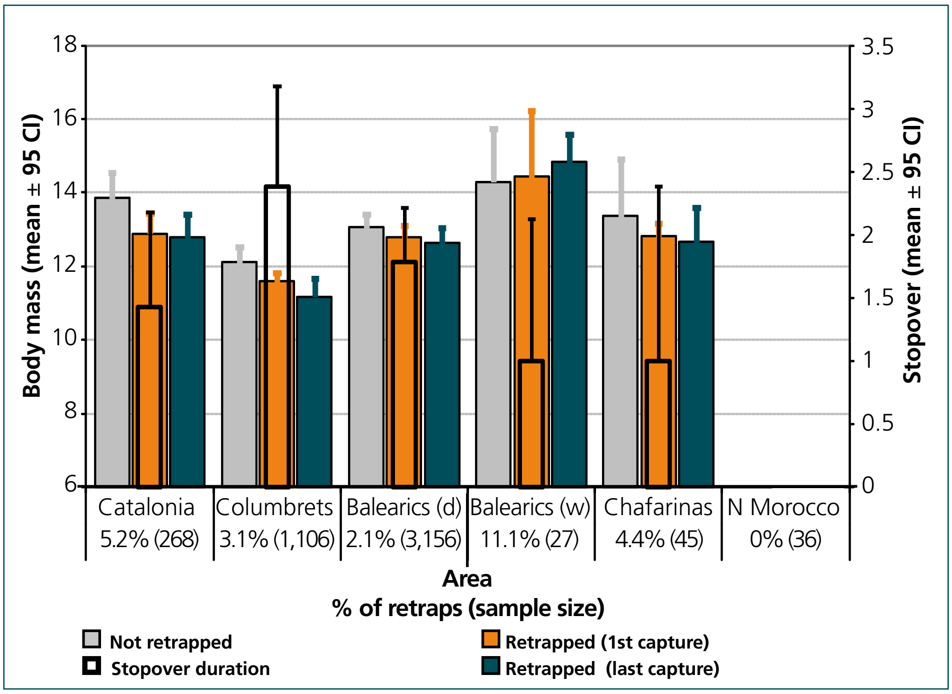


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



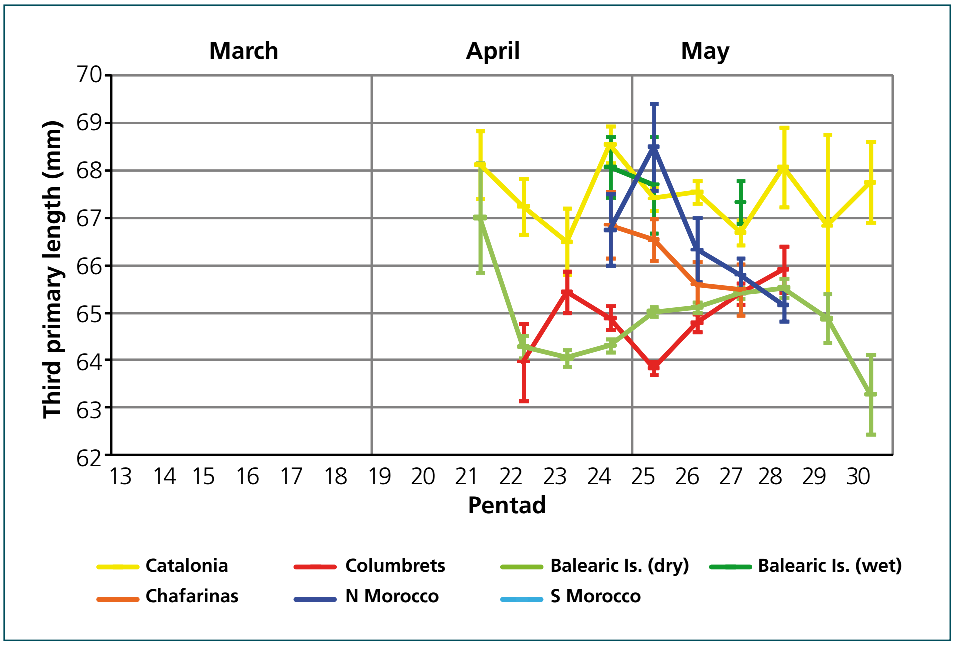


Figure 6. Temporal variation of third primary length according to area.

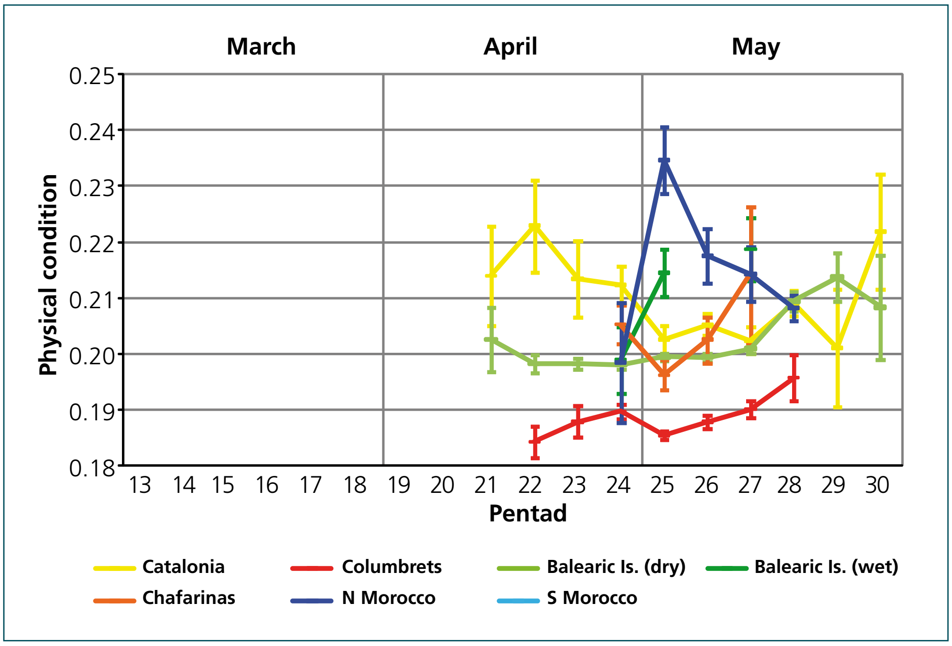


Figure 7. Temporal variation of physical condition according to area.

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

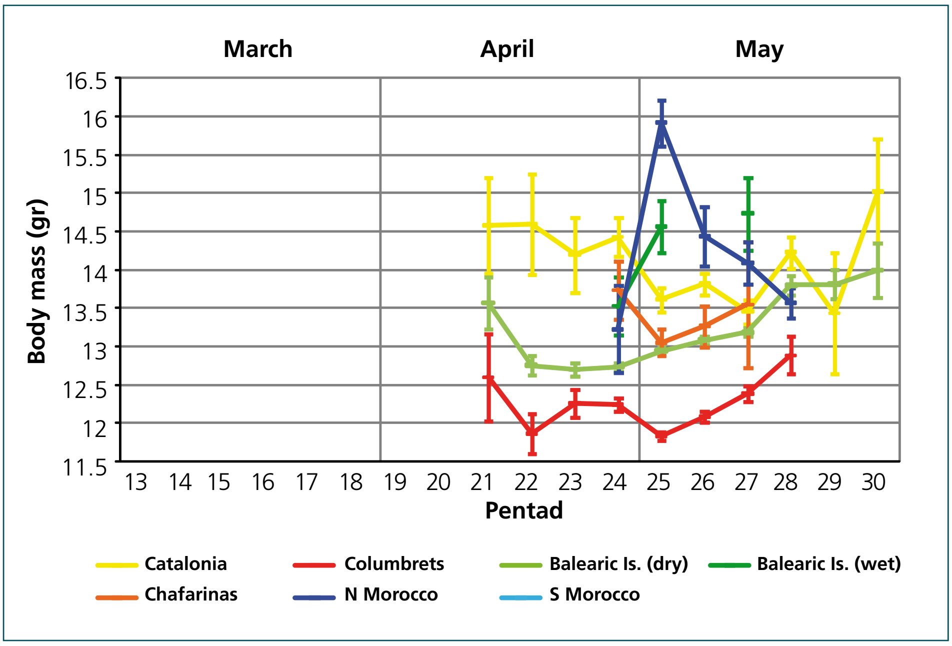


Figure 9. Temporal variation in fat score according to area.