Sedge Warbler *Acrocephalus schoenobaenus*

Germán López-Iborra & Joan Castany

Range

The Sedge Warbler is a long-distance migrant that breeds throughout the western Palaearctic, from France and Ireland east to western Siberia (Cramp, 1992). It winters in sub-Saharan Africa, from Senegal to Ethiopia and S Africa. Annual survival rates in the British population show strong inter-annual variations that depend on rainfall in W Africa, which seems to be the main determinant of population fluctuations (Peach et al., 1991). This species is absent from or is very scarce in the Mediterranean peninsulas, and reproduction in the Iberian Peninsula is only sporadic with no recent confirmed records (Fernández & Bea, 2003). It does not breed at the study sites.

Migratory route

The recovery map indicates that the origin of birds passing through the study area corresponds to a narrow area of W Europe consisting mainly of Great Britain, France, Belgium and the Netherlands (fig. 1). Unlike in autumn, birds avoid the westernmost parts of Iberian Peninsula and use a more easterly route (Cantos, 1992). Birds from adjacent C European countries migrate largely through the Italian Peninsula and the Balkans (Zink, 1973; Busse, 2001; Procházka & Reif, 2002; Spina & Volponi, 2009), thus revealing the existence of a clear migratory divide. In all areas movements are largely in a N-NE direction (present data; Zink, 1973; Wernham et al., 2002; Bønløkke et al., 2006; Spina & Volponi, 2009), suggesting that good numbers migrate across the Mediterranean Sea. This view is further supported by the relatively large number of recoveries from Els Columbrets/Balearics (11 *vs.* 28 in Catalonia, compared to 12 *vs.* 73 in the Reed Warbler, a species markedly less prone to sea crossing).

Movements of birds recovered in Els Columbrets and the Balearics are somewhat more westwards (N-NW rather than N-NE) than those from Catalonia. This difference may be due to the fact that a good number of birds are driven on to the islands, probably by bad weather, from the west or even continental Spain (hence the subsequent NW movements). On the other hand, this difference also seems to reflect a scarcity of passage across the huge area of open sea lying between the Balearics and Sardinia since otherwise more recoveries from more eastern (C European) birds would occur in the Balearics (as occurs in many other species due to the funnel effect produced by these islands). Some reluctance to cross the open sea is also reported in the C Mediterranean, where birds from a broad longitudinal origin seem to use Italy as a bridge (Spina & Volponi, 2009). Thus, although the species does migrate across the Mediterranean Sea, its greatest concentrations seem to move through the Balearics and the Italian Peninsula rather than the area in between, further evidence of the migratory divide observed between W and C European populations.

The bulk of captures take place in wetlands, particularly those in continental areas (fig. 2). However, there is also a great deal of variation, suggesting that the particular characteristics of these areas may have a strong influence on their attractiveness to the species. Captures are remarkably large in some oases in S Morocco and in wetlands in N Morocco, which agrees with the species' distinctly greater presence in NW Africa during spring than in autumn (Thévenot et al., 2003; Isenmann et al., 2005).

Phenology

Passage lasts for three months (fig. 3). Although some birds are captured in the first half of March, passage increases progressively in the second half of the month and reaches a maximum in mid-April. However, birds are detected at some Iberian localities in February (Tellería et al., 1999, pers. obs.). Passage is still intense in the second half of April, but decreases gradually throughout May. The phenology differs between the main study regions. In N Morocco the main passage period takes place during the first half of April (but no data are available from March), in Catalonia during the second half of April, and in the Balearics/Els Columbrets between late April and mid-May. Passage through Catalonia is similar to that reported for C Spain (Bermejo & De la Puente, 2002), while the pattern observed in the Balearics/Els Columbrets is more similar to that reported from the Tyrrhenian islands and Switzerland (Spina et al., 1993; Naumary et al., 2007). In the wetlands of S-SE Spain captures peak at the end of March (Cortés et al., 2007) or in the first two weeks of April (El Hondo, own data), while very few individuals are ringed in May. Available data from S Morocco indicates that the bulk of passage occurs in March (present data; Thévenot et al., 2003; Gargallo et al., unpubl.), similar to S Israel (Morgan & Shirihai, 1997).

These marked latitudinal differences in the timing of the main passage period suggest a slow advance of the migratory wave. The later passage of birds through the Balearics/Els Columbrets compared to Catalonia is difficult to explain, but may reflect greater pressure on late returning birds to take more direct but more dangerous routes across the sea. The recoveries do not show any trend regarding the date of passage through the study area and latitude of capture in more northern Europe.

Biometry and physical condition

Mean values of the third primary length range from 47.0 in Chafarinas to 51.8 in the wet Balearics (table 1), and overall are slightly smaller than in birds crossing the C Mediterranean (mean 51.8, n = 231; Spina et al., 1993) which migrate further to the east and north (Spina & Volponi, 2009). Third primary length is significantly lower in the Balearics, Els Columbrets and N Morocco than in Catalonia and the wet Balearics. Mean values of wing length vary from 65.6 in Els Columbrets to 67.2 in the wet Balearics. Despite the fact that males, which are larger, are known to arrive 1-2 weeks earlier than females at their breeding grounds and that adults precede second-year birds (Cramp, 1992), this is the only species of the genus analysed here with no significant decrease in third primary length over time (fig. 6). The protracted migratory season and differences in migration timing of different populations probably dilute such differences.

Mean body mass varies from 9.1 in Las Chafarinas (only two birds) to 13.1 in the wet Balearics; the range of mean fat score ranges between 0 and 5.1 in the same sites (table 1). There is a tendency for weight and physical condition to increase throughout the season, particularly marked in Catalonia (figs. 7-8). Birds caught in the wet Balearics are significantly heavier and present higher fat reserves than in the rest of localities. Birds with low fat scores (below 3) reach 11% in the wet Balearics, but as much as 59% and 64% in the dry Balearics and on Els Columbrets, respectively. Birds from the wet Balearics also have better physical condition, while those from the dry Balearics are distinctly worst than those from Catalonia and N Morocco. The higher body mass and fat levels in the wet Balearics compared to Catalonia may reflect the fact that birds from the islands still have to cross a geographical barrier and thus need to regain further energetic reserves.

The differences between Morocco and Catalonia in third primary length may reflect differences in origin of birds passing through these localities, although the differences found between Els Columbrets and, particularly, the dry and wet Balearics merit further attention given the proximity of these areas. Birds from these wetlands are also in much better condition than in the other dry islands, both in terms of fat reserves and physical condition. These results strongly suggest that these isolated sites with a total absence of suitable habitat attract to a greater extent birds in poor body condition with a greater need to stopover. The fact that these birds also have shorter wings suggests that smaller size can lead to greater energetic stress (due to poorer flight capacity; *cf.* Newton, 2008; Saino et al., 2010), or that females or younger individuals (with shorter wings) may take fewer risks (being less urged to migrate faster and arrive earlier) and thus be more inclined to stop at suboptimal habitats (but see Saino et al., 2010). Birds stopping at these wetlands may also gain mass faster and involve a major proportion of dominant birds (i.e. males; the species is known to hold territories during migration; Cramp, 1992), or a higher number of birds that have already been at the site for a few days (either at the site itself or in the surrounding area), all of which means that on average birds will have better body condition and larger size.

Body mass in S Morocco is distinctly higher than that obtained in much larger datasets from the same area (mean 9.8, n = 150; Ash, 1969; Gargallo et al., unpubl.). Differences are probably due to interannual or, more probably, site-related variation in the condition of birds. Overall mean body mass (9.9) in the area is similar to that reported in S Israel (10.2), but 10% lower than that observed in N Morocco (mean 10.8, n = 141; present data; Smith, 1979). Body mass in the dry Balearics and on Els Columbrets is similar to that reported in other islands from the C Mediterranean (mean 10.7, n = 231; Spina et al., 1993) and only marginally below that of N Morocco. In Catalonia body mass is very similar to that observed in more northern W Europe (means ranging 11.7-12.0 in Wales and Netherlands; Baggot, 1986; Ormerod, 1990; Cramp, 1992) and only slightly higher, but not statistically so, than in N Morocco. The overall pattern of variation in body mass suggests that birds regain reserves to certain degree after crossing the Sahara (see below also). However, similar body mass from N Morocco and Catalonia north to Britain and C Europe indicates that birds seem to be able to regain some mass also along the continental route and thus do not usually need to fatten up markedly and undertake long flight bouts. Birds trapped in the dry Balearics/Els Columbrets show, at most, only *c.* 1-6% poorer body condition than in N Morocco, suggesting that on departure from NW Africa they have markedly higher body mass average than that observed in N Morocco.

Stopover

In N Morocco fuel deposition rates are distinctly positive and stopovers –although not significantly so– are longer than in the other areas (fig. 5, table 2). This pattern is similar to that observed at Eilat, S Israel, where average stopover is 5.8 days and mean daily mass gain 0.18 (Yosef & Chernetsov, 2004), in accordance with the apparent value of this region as a reliable stopover site. Birds retrapped in the dry Balearics tend to be in poorer condition than those leaving the area immediately afterwards, but differences are not significant. The larger sample from Catalonia shows that birds migrating through continental Spain usually do not stay in the area several days, and that birds that stay, often do not attain a significant increase in mass; a pattern similar to this is found in the Baltic (Bolshakov et al., 2003a). No birds were retrapped in the other regions (although the sample is very small from Els Chafarinas and the wet Balearics).

The species is known to be particularly efficient at finding unpredictable food resources (Cramp, 1992; Chernetsov & Titov, 2001; Zwarts et al., 2009) and, in fact, long stopovers are known to occur on some Mediterranean islands (*e.g.* in Malta spring migrants mostly stop for 5 days; Cramp, 1992). This species may, therefore, make rather long stopovers at just a few particularly good sites while showing little inclination to stop in other areas. However, as suggested by biometrical data (see above) and the results outlined here and by Bolshakov et al. (2003a), migration through Europe seems to take place using short flight bouts and brief stopovers. The lack of retraps in the wet Balearics does not support the view that these areas may include a smaller proportion of recently landed birds. However, the sample size is too small to be conclusive.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	453	66.5 ± 2.1 (56.0-71.5)	51.2 ± 1.8 (46.0-56.0)	11.8 ± 1.3 (8.0-15.9)	3.7 ± 1.5 (0-7)
Columbrets	40	65.6 ± 1.9 (61.0-69.0)	50.3 ± 1.4 (47.5-53.0)	11.1 ± 2.2 (8.4-16.8)	2.5 ± 2.2 (0-7)
Balearics (dry)	118	66.0 ± 2.5 (61.0-72.0)	50.5 ± 2.3 (46.0-56.0)	10.6 ± 1.7 (7.9-16.0)	2.1 ± 1.9 (0-7)
Balearics (wet)	18	67.2 ± 2.0 (63.0-71.5)	51.8 ± 1.9 (47.5-56.0)	13.1 ± 1.9 (9.8-16.3)	5.1 ± 1.8 (2-7)
Chafarinas	2		47.0 ± 1.4 (46.0-48.0)	9.1 ± 0.1 (9.0-9.2)	0.0 ± 0.0 (0-0)
N Morocco	57	65.9 ± 2.0 (62.0-71.0)	50.2 ± 1.8 (47.0-55.0)	11.2 ± 1.4 (8.3-15.4)	2.8 ± 1.7 (0-7)
S Morocco	10	66.2 ± 2.2 (63.0-69.5)	50.1 ± 1.4 (47.0-52.0)	11.2 ± 1.1 (9.5-13.1)	3.6 ± 1.1 (2-5)

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	-0.03 ± 0.19 (29)		0.37 ± 0.54 (6)			0.24 ± 0.19 (5)
Retraps >1 day	0.20 ± 0.17 (17)		0.37 ± 0.54 (6)			0.24 ± 0.19 (5)

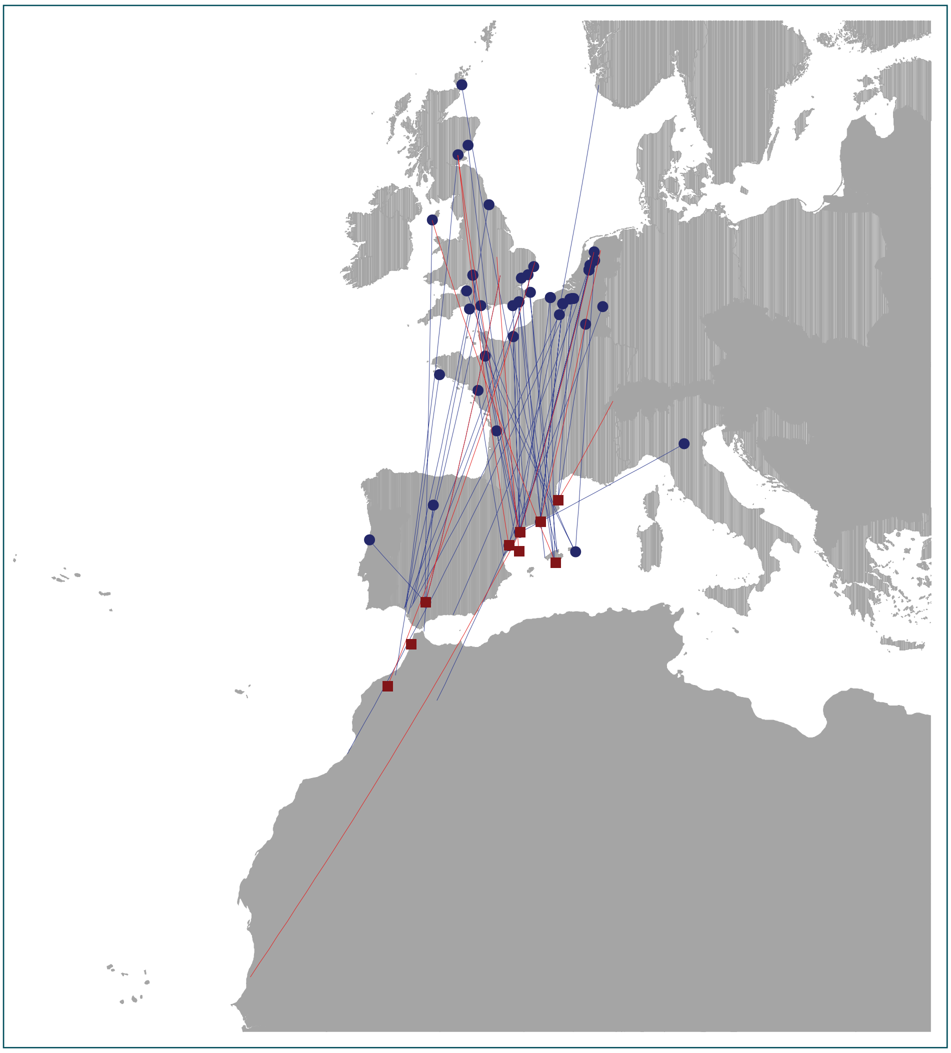


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

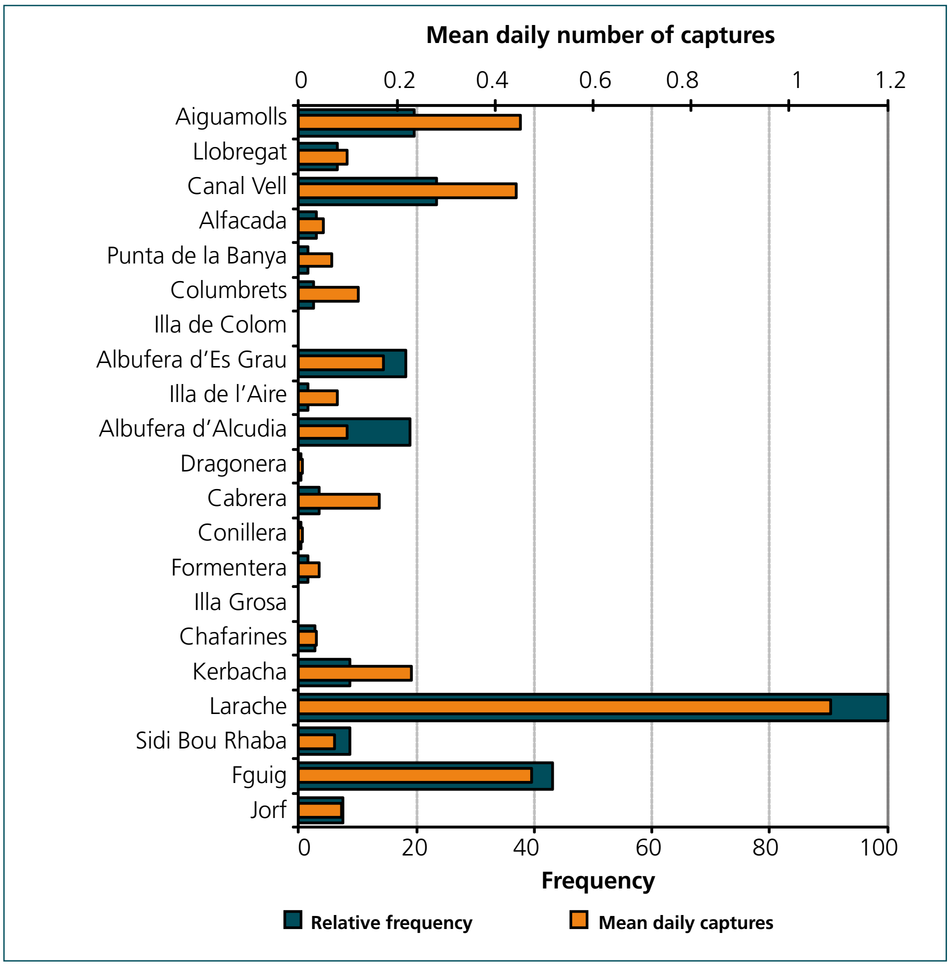


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

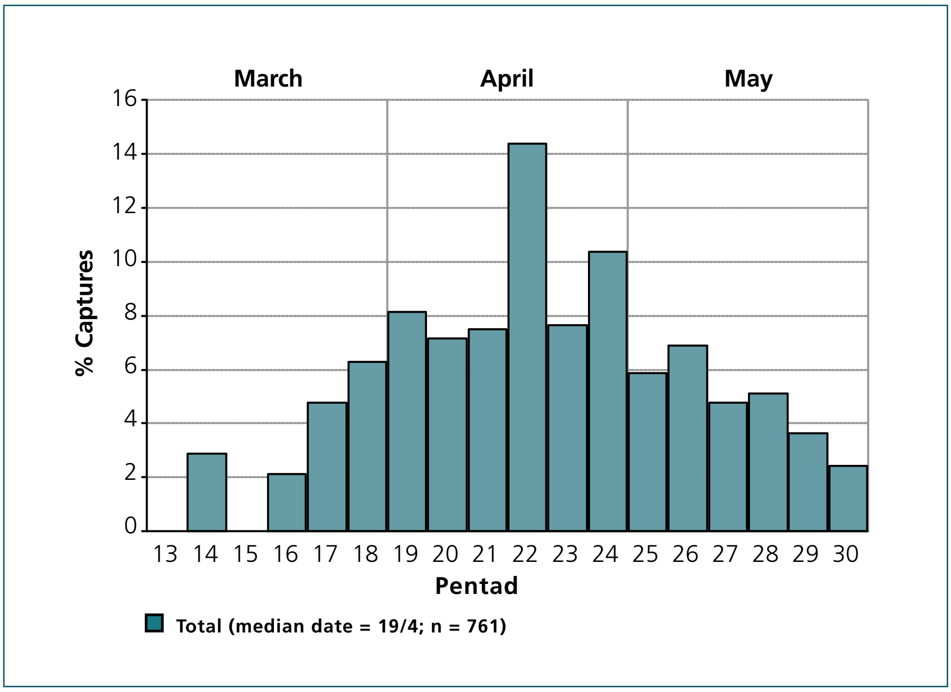


Figure 3. Frequency of captures during the study period.

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

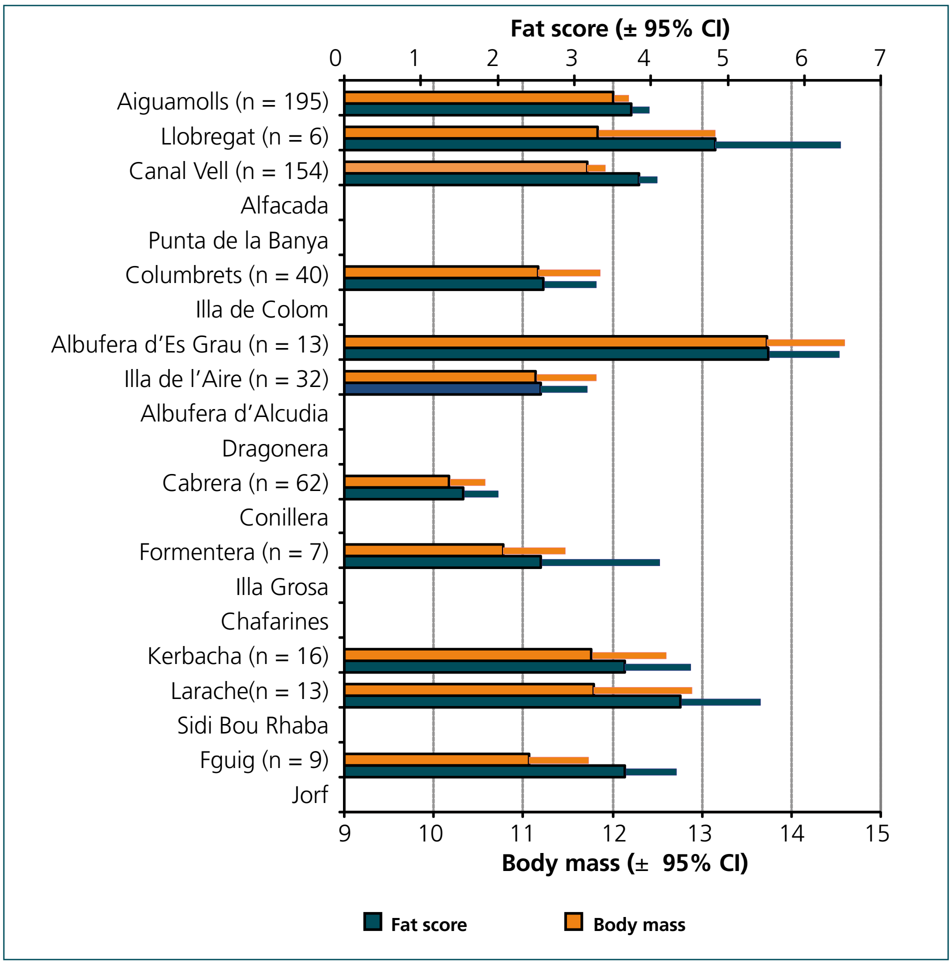
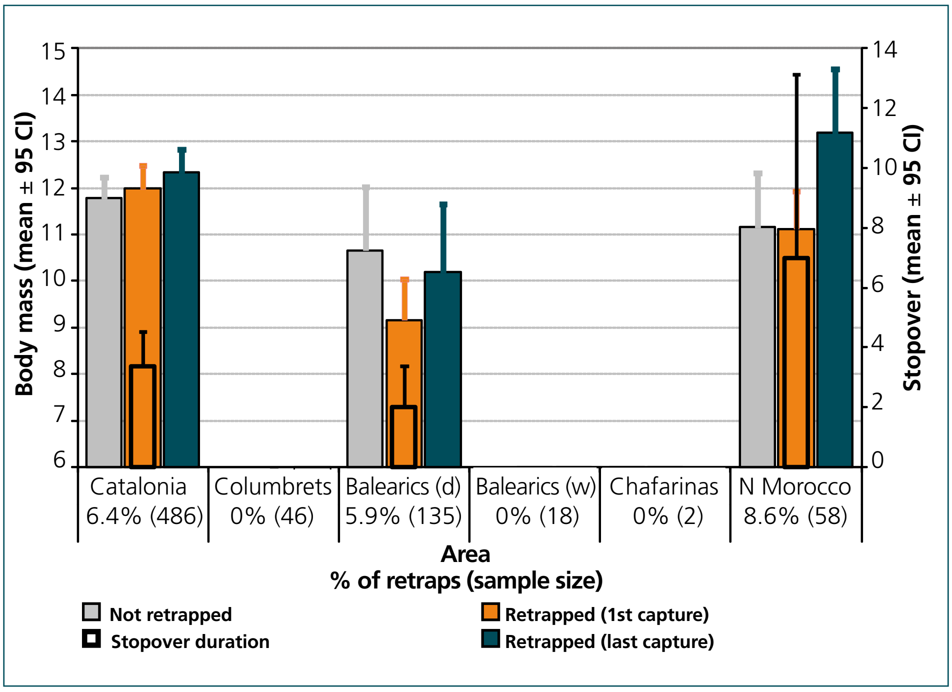


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



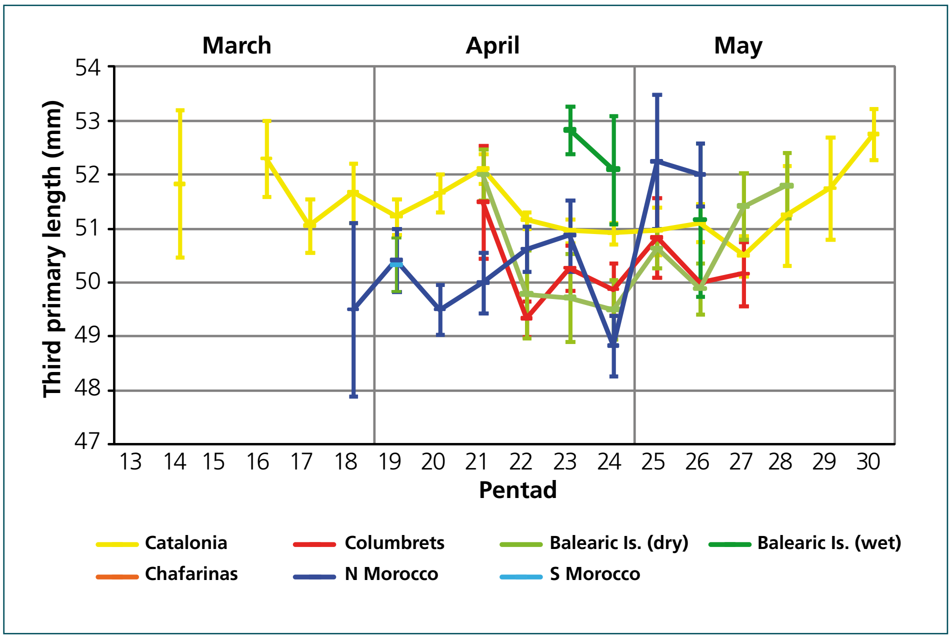


Figure 6. Temporal variation of third primary length according to area.

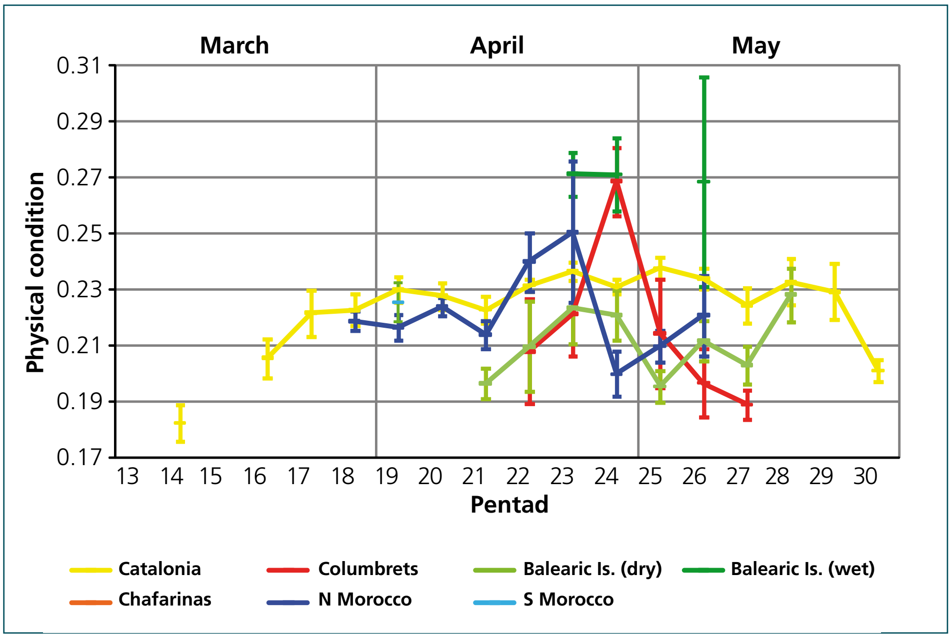


Figure 7. Temporal variation of physical condition according to area.

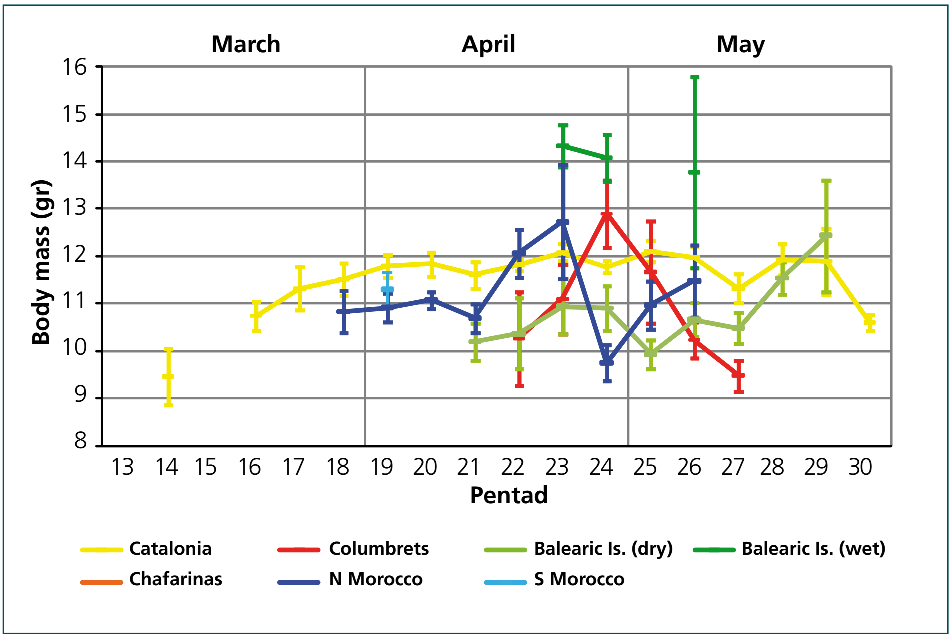


Figure 8. Temporal variation in body mass according to area.

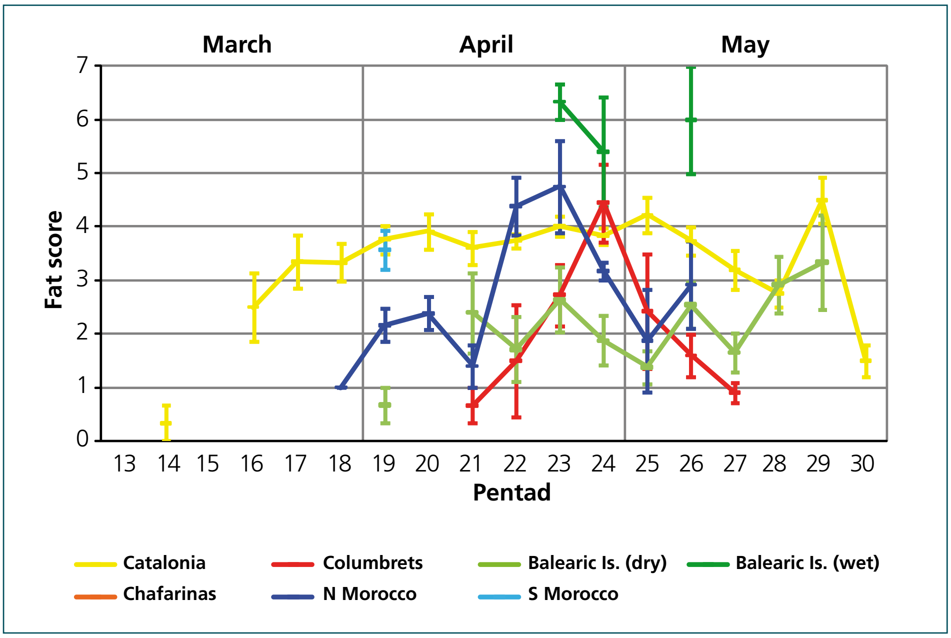


Figure 9. Temporal variation in fat score according to area.