Spring migration in the western Mediterranean and NW Africa: the results of 16 years of the *Piccole Isole* project

G. Gargallo, C. Barriocanal, J. Castany,
O. Clarabuch, R. Escandell, G. López-Iborra,
H. Rguibi-Idrissi, D. Robson & M. Suárez

Monografies
del Museu de Ciències Naturals
n° 6
any 2011

Els autors

Gabriel Gargallo has a Diploma from the *École Pratique des Hautes Études* (Montpellier) and is General Coordinator of the Catalan Ornithological Institute. Since 1992, he has been coordinating the *Piccole Isole* project in the western Mediterranean.

Carles Barriocanal has a PhD in Geography and is an associate lecturer at Girona University. He collaborates closely with the bird migration projects run by the Catalan Ornithological Institute and has published several papers on the subject.

Joan Castany has a PhD in Biological Sciences and a degree in Pedagogy. He has been director of the Bird Migration Centre (*Centro de Migración de Aves*) of SEO-Birdlife for five years and has coordinated the *Piccole Isole* project on Els Columbrets since it began.

Oriol Clarabuch has a degree in Biology and coordinates the Catalan ringing sites involved in the *Piccole Isole* project for the Catalan Ornithological Institute.

Raül Escandell coordinates the ringing projects conducted by the *Societat Ornitològica de Menorca* (SOM) and has been in charge of the *Piccole Isole* sites on Menorca since 1992.

Germán López-Iborra is professor of Ecology at Alicante University, where he undertakes research into the ecology of several species of endangered passerines. He has published several papers on the biology and ecology of passerines.

Hamid Rguibi-Idrissi has a PhD on the migratory strategies and stopover ecology of passerines in Morocco awarded by the Mohamed V University (Rabat) and Karl Von Ossietzky University (Oldenburg). He has published several papers on bird migration and presently coordinates the *Bird Migration Research Group and Ringing Data Management* in Morocco.

David Robson has a degree in biology from the Autonomous University of Barcelona and is member of the Catalan Ornithological Institute and SEO-Birdlife. He is currently focusing his efforts on the effects of climate change on the phenology of trans-Saharan migrants.

Manolo Suárez coordinates ringing projects run by the GOB-Mallorca and is in charge of the *Piccole Isole* sites operating in Mallorca, Ibiza and Formentera.

Monografies
del Museu de Ciències Naturals

1. **Flora del Parc Natural del Cadí–Moixeró i de les serres veïnes (Prepirineus orientals ibèrics)**
   J. Vigo, I. Soriano, J. Carreras,
   P. Aymerich, E. Carrillo, X. Font,
   R. M. Masalles & J. M. Ninot

2. **Mucho más que plumas**
   J. C. Senar

3. **El Museu Martorell, 125 anys de Ciències Naturals (1878–2003)**
   A. Masriera

4. **La cuenca carbonífera de Surroca–Ogassa (Ripollès, Cataluña, España)**
   Historia económica, minera y geológica y catálogo de la flora carbonífera catalana del Museu de Ciències Naturals de Barcelona
   J. Gómez–Alba

5. **Paseriformes del Occidente de México: morfometría, datación y sexado**
   S. Guallar, E. Santana, S. Contreras,
   H. Verdugo & A. Gallés

6. **Spring migration in the western Mediterranean and NW Africa: the results of 16 years of the *Piccole Isole* project**
   G. Gargallo, C. Barriocanal, J. Castany,
   O. Clarabuch, R. Escandell, G. López-Iborra,
   H. Rguibi-Idrissi, D. Robson & M. Suárez

Spring migration in the western Mediterranean and NW Africa: the results of 16 years of the *Piccole Isole* project

museu de ciències naturals de Barcelona

Spring migration in the western Mediterranean and NW Africa: the results of 16 years of the *Piccole Isole* project

G. Gargallo, C. Barriocanal, J. Castany,
O. Clarabuch, R. Escandell, G. López-Iborra,
H. Rguibi-Idrissi, D. Robson & M. Suárez

GOB Grup Balear d'Ornitologia i Defensa de la Naturalesa
GRUP AU D'ORNITOLOGIA
ICO Institut Català d'Ornitologia
SOM Societat Ornitològica de Menorca
جامعة شعيب الدكالي Université Chouaïb Doukkali
Ajuntament de Barcelona Institut de Cultura
GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN
CSIC

To all the ringers who have participated in this project,
for their efforts and commitment to the study of bird migration
in the W Mediterranean and NW Africa.

A tots els anelladors que han participat en aquest projecte,
pel seu esforç i dedicació a l'estudi de la migració dels ocells
a l'oest de la Mediterrània i el nord-oest d'Àfrica.

Disseny de la coberta: Fons Gràfic
Fotografia de la coberta: Jordi Escandell

Monografies del Museu de Ciències Naturals 6, 2011

Spring migration in the western Mediterranean and NW Africa: the results of 16 years of the *Piccole Isole* project

Editors en cap: A. Omedes & J. M. Montserrat

Comitè editorial: C. Curto, J. C. Senar & A. Susanna

Autors: G. Gargallo, C. Barriocanal, J. Castany, O. Clarabuch, R. Escandell, G. López-Iborra, H. Rguibi-Idrissi, D. Robson & M. Suárez

Entitats col·laboradores: Institut Català d'Ornitologia
GOB-Mallorca
Societat Ornitològica de Menorca
Grup AU d'Ornitologia
Université Chouaib Doukkali

Aquest projecte no hauria estat possible sense el suport de:

Fotografies interiors: Raül Aymí, Juan Bernal, Raül Calderón, Oriol Clarabuch i Gabriel Gargallo
Fotografia contraportada: Eladi Ribes

Edició: Institut de Cultura de Barcelona, Ajuntament de Barcelona

Maquetació: Montse Ferrer
Fotomecànica i impresió: .....
ISSN: 1695-8950
Dipòsit legal: Z–339–2003

Index

Presentació

Saber com es barregen o separen les diferents poblacions d'aus durant els moviments migratoris es bàsic per poder entendre el procés evolutiu associat a la migració. La connectivitat és, avui, un dels conceptes de major interès en ecologia i biologia de la conservació. La present monografia tracta de ple aquest concepte presentant dades sobre la migració dels ocells a l'est de la Península i al nord de l'Àfrica. Aquest projecte és especialment important ja que aplega el treball d'un gran nombre d'investigadors en un marc geogràfic de gran abast. La coordinació i els esforços que això implica fan que, en molts casos, aquest tipus d'estudis no es pugin dur a terme. Aquest és, però, un bon exemple que sí són possibles i que el rèdit científic que produeixen és alt.

Un valor afegit del present treball és que s'ha perllongat durant 16 anys. L'ús de sèries temporals llargues té un gran interès per poder entendre processos dinàmics, especialment en un moment on l'estudi i la comprensió del canvi climàtic centren gran part de la recerca. Aquestes sèries temporals, atesa la idiosincràsia del sistema vigent de finançament de la recerca, són tot sovint difícils d'obtenir. La tenacitat i l'entusiasme dels diferents grups d'investigadors i anelladors que participen en aquest estudi han permès portar-lo a bon terme i obtenir dades de gran solidesa.

És important emfatitzar que la present monografia és resultat del treball conjunt d'investigadors i anelladors. Els anelladors són un col·lectiu amb un gran entusiasme i dedicació, i la seva col·laboració exemplifica el gran potencial que suposa implicar els ciutadans en projectes, especialment els de gran abast. La col·laboració dels ciutadans en estudis de la diversitat natural és un dels objectius del nostre Museu per als propers anys, que ja hem començat a potenciar.

Anna Omedes
Directora
Museu de Ciències Naturals de Barcelona

Presentación

Saber como se mezclan o separan las diferentes poblaciones de aves durante los movimientos migratorios es básico para poder entender el proceso evolutivo asociado a la migración. La conectividad es, hoy, uno de los conceptos de mayor interés en ecología y biología de la conservación. La presente monografía trata de lleno este concepto presentando datos sobre la migración de las aves en el este de la Península y el norte de África. Este proyecto es especialmente importante puesto que reúne el trabajo de un gran número de investigadores en un marco geográfico de gran alcance. Debido a la coordinación y los esfuerzos que esto implica, en muchos casos este tipo de estudios no pueden llevarse a cabo. Pero este es un buen ejemplo de que sí son posibles y producen un elevado rédito científico.

Un valor añadido del presente trabajo es que se ha prolongado durante 16 años. El uso de series temporales largas tiene un gran interés para poder entender procesos dinámicos, especialmente en un momento en que el estudio y la comprensión del cambio climático centran gran parte de la investigación. Estas series temporales, dada la idiosincrasia del vigente sistema de financiación de la investigación, son muy a menudo difíciles de obtener. La tenacidad y el entusiasmo de los diferentes grupos de investigadores y anilladores que participan en este estudio han permitido llevarlo a buen término y obtener datos de gran solidez.

Es importante poner de relieve que la presente monografía es resultado del trabajo conjunto de investigadores y anilladores. Los anilladores son un colectivo con un gran entusiasmo y dedicación, cuya colaboración ejemplifica el gran potencial que supone implicar a los ciudadanos en proyectos, especialmente los de gran alcance. La colaboración de los ciudadanos en estudios de la diversidad natural es uno de los objetivos de nuestro Museo para los próximos años, que ya hemos empezado a potenciar.

Anna Omedes
Directora
Museo de Ciencias Naturales de Barcelona

Presentation

Knowing how different populations of birds mix and separate during their migratory journeys is essential to understanding the evolutionary process associated with migration. Today, connectivity is one of the hot topics in ecology and conservation biology. This paper deals fully with the concept and presents data on the migration of birds in the east of the Iberian Peninsula and in North Africa. This project is particularly important as it brings together the work of a large number of researchers over a wide geographic area. Due to the coordination and effort that this involves, it is often not possible to carry out studies of this kind. But this is clear proof that they are possible and that they produce a considerable amount of science.

One added value of this study is that it has lasted 16 years. The use of long-term time series is of great interest in order to understand dynamic processes, especially when a major part of research is focused on the study and understanding of climate change. Given the idiosyncrasies of the current system of research funding, these time series are very often difficult to obtain. The tenacity and enthusiasm of the different research and ringing groups taking part in this study have made it possible to carry it out successfully and obtain very solid data.

It is important to note that this paper is the result of the joint work of researchers and ringers. The ringers are a highly enthusiastic and dedicated group and their collaboration exemplifies the potential of getting the public involved in projects, particularly those with a large scope. The collaboration of the public in natural-diversity studies is one of the goals of our museum for the coming years and is one that we have already begun to potentiate.

Anna Omedes
Director
Barcelona Natural Science Museum

Foreword

The crossing of ecological barriers represents the most challenging and potentially risky phase of migratory flights. However, each spring huge numbers of migrants cross large stretches of the Sahara desert and Mediterranean Sea with fast and energy demanding endurance flights to reach the breeding grounds as early as possible.

From the energetic point of view, all these migrants need suitable stopover habitats while confronted with the sea crossing. And the system of Mediterranean islands, widely distributed across longitude and latitude, offers a unique opportunity to investigate the fascinating patterns of migratory flights from Africa towards Europe.

The Mediterranean is a centre of biodiversity and endemism, and during the migratory seasons it is also a key area for a large array of species breeding across the Western Palaearctic. Mediterranean countries therefore share a great responsibility for the monitoring of these movements across the sea and for the conservation of huge numbers of migratory birds.

Traditionally, bird migration studies in Europe originated and developed in northern countries and were mostly concentrated on autumn movements; much less was known, in fact, on the patterns and strategies followed by return spring migrants.

Italy is a natural bridge stretched across the Mediterranean and has a large number of islands widely distributed mainly across its western seas. As a student, I had the unique chance to study bird migration through ringing on the remote, wild and fascinating island of Montecristo, where I had realised the great potential of Mediterranean islands for ringing studies, especially through the amazing numbers and diversity of spring staging migrants.

For all these reasons, and also for testing the potential of Italian ringers in carrying on co-ordinated and standardised ringing projects, in 1988 I launched the Progetto *Piccole Isole*. After 24 years, it is with my greatest pleasure that I salute the publication of this beautiful monograph, presenting results obtained by the *Piccole Isole* in Spain and North Africa.

It is amazing what the enthusiasm, commitment, efforts and capabilities of all the Spanish and Moroccan friends have produced during 16 years of their involvement in the project. When I started contacting colleagues in other Mediterranean countries to propose them to join the project, I would have never dreamed having the honour today of writing these few words of preface to this comprehensive, detailed and most interesting scientific report.

The colleagues and good friends involved in the *Piccole Isole* in the Western Mediterranean could realise the crucial link between North Africa and the Mediterranean for the study of migratory movements in act, offering now new insights on seasonality of movements, species distribution across stopover areas, differential migration of sex- and age-classes, conditions of staging migrants, stopover duration, morphometrics and connectivity of a wide sample of specie of both intra-Palaearctic and trans-Saharan migrants.

If the Mediterranean acts as an important barrier between Africa and Europe, it also has, in fact, the important role of a link between the two continents for migratory birds, whose seasonality of passage across the basin is governed, as we could show thanks to results of the *Piccole Isole,* by ecological factors acting both in Africa and Europe.

The volume you will have now the chance to read provides with the most detailed data inventory ever produced on ringing studies in the Western Mediterranean. These results also confirm the amazing potential and productivity of the different research institutions involved in the project as one of the most important and promising ornithological realities within, as well as outside the Mediterranean.

I hope the activities of the *Piccole Isole*, which next year will celebrate its –first!– 25 years, will continue also in Morocco and Spain, producing long time-series of migration data which are of crucial importance to monitor and understand the environmental effects of global climate change, as measured through that most sensitive group of indicators represented by migratory birds.

I warmly congratulate the Museu de Ciencies Naturals as the publisher, and the institutions making possible the *Piccole Isole* network in the Western Mediterranean for this volume and wish all the best for the continuation of a joint initiative which has also created a most pleasant and positive exchange of experiences, enthusiasm and friendship across our *Mare nostrum*.

Fernando Spina
Head, ISPRA Italian Ringing Centre
Co-ordinator *Progetto Piccole Isole*

Acknowledgements

This project was made possible by the continued support received from the following institutions: Université Chouaib Doukkali, Generalitat de Catalunya, Parc Natural dels Aiguamolls de l'Empordà, Parc Natural del Delta de l'Ebre, Consorci per a la Protecció i la Gestió dels Espais Naturals del Delta del Llobregat, Obra Social de Catalunya Caixa, Espais de Natura Balear, Parc Nacional de Cabrera, Parc Natural de Cala d'Hort, Parc Natural de s'Albufera d'Alcúdia, Parc Natural de Sa Dragonera, Parc Natural Albufera d'Es Grau, Govern de les Illes Balears (Conselleria d'Agricultura, Medi Ambient i Territori), Consell Insular de Menorca, Agència Menorca Reserva de Biosfera, Parc Natural de Ses Salines d'Eivissa i Formentera, GEN-GOB-Eivissa, Diputació de Castelló, Generalitat Valenciana (Conselleria d'Infraestructures, Territori i Medi Ambient), Asociación de Naturalistas del Sureste, Life *Larus audouini*, Parque Nacional de Chafarinas, Institut Menorquí d'Estudis and Observatori Socioambiental de Menorca.

Moreover, many other people and institutions helped in a lot of ways during these years of work, either by collaborating with the coordination tasks or by helping with fieldwork, logistics or the obtaining of permits. Our warm thanks to all them: Famille Bounjim de Larache, Salima Hamidi (Faculté des Sciences d'Oujda), Abdssalam Bouchafra (Directeur de la Réserve Biologique de Sidi BouGhaba), Haut Commisariat aux Eaux et Forêt et à la Lutte contre la Désertification, A. M. Mohamed Ribi, H. Mesbah, Reserva Natural de Sebes, Ajuntament de Flix, and GOB-Menorca.

Our thanks are also due to all the authors of the species accounts for their patience during the drawn-out editorial process. Carles Barriocanal and David Robson participated very actively throughout this process and wrote many species accounts thanks to a grant for scientific research awarded by the Catalan Ornithological Institute. We would also like to extend our thanks to Joan Carles Senar and Montse Ferrer for their support during all the editorial tasks and to Mike Lockwood for revising the English language. Fernando Spina and Felix Liechti made helpful suggestions that improved various aspects of this monograph.

Finally, but most importantly, this work would not have been possible without the involvement and enthusiasm of the following ringers:

Aiguamolls
Héctor Andino, Montserrat Argullós, Enric Badosa, Oriol Baltà, Carles Barriocanal, Nick Bayly, David Bigas, Daniel Burgas, Raül Calderón, Jaume Campderròs, Alda Carreras, Oriol Clarabuch, Josep Maria Cumplido, Gabriel de Jesús, Enric Fàbregas, Jordi Feliu, Carles Feo, Joan Carles Fernández, Miguel Angel Fuentes, Ernest Garcia, Gabriel Gargallo, Núria Gaxas, Lluís Gay, Santi Guallar, Javier Ibáñez, Cristian Jensen, Lluc Julià, Maria Llover, Jose Manuel Martínez, Stephen Menzie, Marc Olivé, Marc Pérez, Carles Pibernat, David Robson, Albert Roca, Daniel Roca, Josep Rost, Sergi Sales, Oriol Solé, Rafael Torralbo, Joan Ventura, Xavi Vila and Joaquim Vilagran.

Albufera d'Alcúdia
Maties Rebassa and Josep Sunyer.

Albufera d'Es Grau
Pedro Bescós, Santi Campos, Juan José Carreras, Raül Escandell, Joan Carles Fernández, Oscar García, Emili Garriga, Lluc Julià, Martin Ley, Mercè Loukota, Xavier Méndez, Ismael Pelegrí and Alicia Piolí.

Alfacada
Joan Aymerich, Oriol Baltà, Juan Bernal, Birgitta Bueche, Raül Calderón, Oriol Clarabuch, Petra Dinnebier, Carles Feo, Suni Garcia, Gabriel Gargallo, Cristian Jensen, José Manuel Martínez, Marc Olivé and Iben Hove Sorensen.

Cabrera
Joan Carles Abella, Eduard Amengual, Jaume Bonnín, Eulalia Caballé, José Esteban Cardona, Pere Lluís Dietrich, Pere Joan Garcias, Gabriel Gargallo, Juan Miguel González, Miquel McMinn, Santiago Guallar, Carlos Herrero, Manuel Polo, Maties Rebassa, Ana Iñigo, Joan Francisco Riera, Ángel Sallent, Maria Teresa Solns and Josep Sunyer.

Canal Vell
Oriol Baltà, Paul Baxter, David Bigas, Yago Brugnoli, Raül Calderón, Oriol Clarabuch, Jordi Feliu, Ernest Garcia, Javier Ibáñez, Jordi Jofre, Xavier Larruy, Carles Llevaria, Marc Llobet, Ana López, Albert Marc Olivé, Marc Pérez, Júlia Piccardo, Albert Roca, Daniel Roca, Núria Rodríguez, Sergi Sales, Albert Vaca and Hywell Waggs.

Chafarinas
Francisco Cantos, José Manuel Igual and Antonio Román Muñoz.

Columbrets
Oscar Aldeguer, Alberto Álvarez, Elena Álvarez, Jenifer Andreu, Carmen Aznar, David Bigas, Albert Cama, Pep Cantó, Javier Cotín, Alvado Diaz, Vicent Esteller, Juan Fernández, Juan Carlos Fernández, Suni Garcia, Alfonso Godino, Fernando González, Pepe Greño, Carlos Gutiérrez, Jose Manuel Herranz, Carlos Herrero, Cristian Jensen, Miguel Ángel Letón, Agustín López, Marcial Marín, Carlos Merino, Juan Monrós, Carlos Moreno, Jesús Notario, Marc Olivé, Alejandro Pascual, Rubén Piculo, David Robson, Vicente José Romero, Iván Sánchez, Bruno Sanchos and Paco Zufiadur.

Conillera
José Esteban Cardona, Josep María Cumplido, Javier García, Santiago Guallar, Oliver Martínez, Adolfo Quiles and Carles Santana.

Dragonera
Eduardo Amengual, Jaume Bonnín, Juan Miguel González, Jesús R. Jurado, Xisco Lillo, Oliver Martínez, Joan Carles Muntaner, Pere Pons, David Robson and Josep Sunyer.

Fguig
Hamid Rguibi-Idrissi.

Formentera (Can Marroig)
Jaume Bonnin, José Esteban Cardona, Santi Costa, Oliver Martínez, Rafel Mas, Steve Nicoll and Biel Sevilla.

Formentera (la Mola)
Joan Carles Abella, Santi Costa, Gabriel Gargallo, Núria Gaxas, Oliver Martínez, Pepe Martínez, Joan Manuel Prats, Isabel Pujol, Marcos Romero and Sipko Wijk.

Illa de l'Aire
Ferran Aguilar, Nat Agulló, Guiem Alfocea, Quim Bach, Oriol Baltà, Carles Barriocanal, Pedro Bescós, David Bigas, Arnau Bonan, Frederic Bosch, Eulàlia Caballé, Raül Calderon, José Antonio Calero, Santi Campos, Josep Capò, Juan José Carreras, Santi Catchot, Thamar Conde, Aitor Díez, Gisela Duran, Joan Elies, Raül Escandell, Vinca Escandell, Àgueda Escaño, Ciara Escoda, Borja Esteban, Joan Castelló, Jordi Feliu, Ángel Fernandez, Joan Carles Fernández, Cristina Fiol, Laia Font, Miquel Angel Fuentes, Enric García, Emili Garriga, Ernest García, Oscar García, Suni Garcia, Núria Gaxas, Maiol Gispert, Roger Jovani, Lluc Julià, Martin Ley, Marc Llobet, Mercè Loukota, Paco Martínez, Josep Mascaró, Xavier Méndez, Ismael Pelegrí, Alicia Piolí, Antoni Pou, Alfred Puig, David Robson, Josepa Rubio, Sergi Sales, Antonio Salmerón Victor Sanz, Clara Soler, Fredy Rivas, Francesc Trabalón, Rafel Triay, Daniel Valverde, Albert Vila, Antonio Vilches and Carles Xamani.

Illa de Colom
Santi Campos, Juan José Carreras, Aitor Díez, Raül Escandell, Vinca Escandell, Cristina Fiol, Oscar García, Emili Garriga, Xavier Méndez, Alicia Piolí and Carles Santana.

Illa Grossa
Ángel Sallent, Ángel Guardiola, José Luis Murcia, José Antonio Barba, Gonzalo G. Barberá, Guillermo Costas, Samuel Peregrina, David Álvarez, Simón Rial, Alberto Pastoriza.

Jorf
Hamid Rguibi-Idrissi.

Kerbacha
Gabriel Gargallo, Javier Jurado, Hamid Rguibi-Idrissi, David Robson and Rafa Torralbo.

Larache
Hamid Rguibi-Idrissi.

Llobregat
Oriol Baltà, Joan Castelló, Raül Calderón, Oriol Clarabuch, Joan Ferrer, Ernest Garcia, Suni Garcia, Marcel Gil, Santi Guallar, Xavier Larruy, Marc Llobet, Judit Mateos, Sergi Sales and Marc Olivé.

Sebes
Joan Carles Abella, Oriol Baltà, Ramon Masip and Rafa Torralbo.

Sidi Bou Ghaba
Hamid Rguibi-Idrissi.

Punta de la Banya
Raül Aymí, Albert Bertolero, Andrew Elliott, Ángel Franch, Isabel Martínez, Albert Martínez, Jordi Martínez, Ramón Massip, Anna Motis, Dani Oro, Eladi Ribes and Rafa Torralbo.

Introduction

Bird migration is one of the most fascinating of all natural events. Yet, migration implies great risks and places huge energetic demands on birds (Sillet & Holmes, 2002; Newton, 2008). As well, in spring birds have to race to reach their breeding grounds as soon as possible in order to establish territories and find a mate (Alerstam, 1990), all of which makes their return journeys demanding in many senses. Furthermore, after wintering in sub-Saharan Africa, long-distance Palaearctic migrants face a particularly difficult task since they have to cross two large geographical barriers in quick succession, the Sahara desert and the Mediterranean Sea.

The Sahara is the largest desert in the world and stretches in a 2,000-km wide north-south strip from the Atlantic coast to the Arabian Peninsula. Despite being mostly devoid of vegetation, this vast area is crossed by over two billion birds twice a year (Moreau, 1972; Hahn et al., 2009), some on direct/non-stop flights and others on intermittent flights during which time they may or may not stop to feed (Biebach et al., 2000; Schmaljohann et al., 2007a). Moreover, in spring the difficulty of crossing the Sahara is further compounded by the headwinds that blow at this time of year (Moreau, 1972). Nevertheless, due to winter rains, once in North Africa birds may benefit from better stopover conditions in spring than in autumn (Moreau, 1972; Alerstam, 1990), although shortly afterwards migrants will be faced with the challenge of crossing the Mediterranean Sea. Distances between the northern and southern shores range from *c.* 20 km across the Straits of Gibraltar to 600-1,000 km across most other parts of this sea. At first glance, the Mediterranean may seem less of an overwhelming geographical barrier than the Sahara, but for the vast majority of migrants landing in the sea means certain death.

Crossing large barriers such as the Sahara desert and the Mediterranean sea entails endurance flights which require large amounts of energy, potential challenges for orientation and drift-compensation (Spina, 2011). Furthermore, in these circumstances adverse weather can also lead to the mass mortality of migrants (Newton, 2008). However, given that birds spend about 90% of their time during migration at stopover sites, in many cases trying to replenish their fuel reserves (Hedenström & Alerstam, 1997; Lindström, 2003), the distribution and quality of stopover areas are probably the most important factors shaping bird migration strategies. During spring, it is well known that most migrants fatten up in the Sahel just south of the Sahara or, to a lesser extent, in wintering or staging areas situated even further to the south (Zwarts et al., 2009; Ottoson et al., 2005). These pre-migratory fattening-up sites are crucial for spring migrants, although the fuel reserves that birds manage to amass there may not be sufficient for crossing the Sahara desert and reaching Europe. Birds may have to refuel in N Africa (Ash, 1969; Rguibi-Idrissi et al., 2003; Maggini & Bairlein, 2011), above all because, once in this region, most birds still have to cross the Mediterranean. Unfortunately, the role of North Africa as a staging-post for spring migrants is still poorly known and, similarly, in general many questions regarding spring migration across the Mediterranean sea remain unsolved.

In 1988 the Italian Bird Ringing Centre launched the *Piccole Isole* project (small islands project, PPI) aimed at understanding the different strategies employed by birds crossing the Mediterranean during their return journeys to Europe. Traditionally, autumn migration had always been well-studied in Europe and by the 1980s very little attention was paid to birds' northward journeys, particularly in the Mediterranean basin (Spina et al., 1993). The *Piccole Isole* project started as a national scheme involving ringing sites on four Tyrrhenian islands (Montecristo, Giannutri, Ventotene and Capri). However, soon afterwards, it increased its geographical scope with the inclusion of ringing sites in the western and eastern Mediterranean and an increase in the number of sites in Italy itself and in nearby areas such as Malta, Corsica and Sardinia. Initially, ringing sites mostly operated during the so-called 'standard period' (April 16–May 15), but subsequently some sites extended this period to 90 days to cover nearly the whole spring migration season (March–May). Nowadays, the project embraces almost 50 ringing sites, on both islands and the mainland, above all in coastal areas. It has spread to seven countries and mobilizes hundreds of ringers every year, thereby ensuring its status as one of the largest ringing projects in the world in terms of geographical coverage, years of operation (24 to date) and the quantity and quality of data obtained (more than a million birds ringed).

Bird ringing has played a crucial part in our understanding of bird migration and bird movements in general (Alerstam, 1990; Berthold, 1996). However, the key to the *Piccole Isole* project was the creation of a network of ringing stations that operate at the same time with the same methodological protocols across a large geographical area, thereby offering a unique opportunity for unravelling complex migratory patterns (Berthold et al., 1991; Spina, 2011). Thanks to this approach, the *Piccole Isole* project has greatly improved our knowledge of bird migration in the Mediterranean, particularly regarding the description of migratory routes, the differential migration of sex- and age-classes, the use of fuel reserves, the effects of weather and the stopover behaviour of birds staging on islands (*cf.* Spina, 2011). However, more importantly still, this network of ringing stations has proved its ability to provide a sound scientific basis for regional conservation policies, so vital in an area under such great pressure from hunting and tourism (Hepburn, 1985; Fenech 1992; Hoballah, 1996).

Since the first *Piccole Isole* sites started to operate in the western Mediterranean in 1992 the project has expanded so that nowadays the data obtained here and in the central Mediterranean form the bulk of the project. Moreover, the addition of a number of ringing stations from Morocco to the excellent coverage of the western Mediterranean (largely due to the number of sites operating constantly in the Balearic Islands and Els Columbrets, as well as in Catalonia in continental NE Spain) has given further value to the whole dataset. This has enabled us for the first time to study bird migration simultaneously right across the Mediterranean basin, not only in the areas from where migrants originate (NW Africa), but also in areas where birds stop while sea-crossing (insular sites) or while following less energetically demanding continental routes (coastal NE Spain). The purpose of this monograph is the presentation of the main results of this study in a synthesis of the first 16 years of operation of the *Piccole isole* project in the western Mediterranean and NW Africa.

Material and methods

The present work summarises the results of 16 years of activity of the *Piccole Isole* Project (PPI) in Morocco, on the Spanish Mediterranean coast and in the Balearic Islands.

Study sites

During the study period a total of 23 different ringing sites operated in the study area (fig. 1). The ringing sites are geographically well separated and are situated in diverse types of habitats in both continental and insular locations (table 1). In all, 11 sites are regarded as continental: five in Morocco and six in Catalonia, NE Spain. Of these, one site is situated at the tip of a long narrow peninsula in the southern part of the Ebro delta (Punta de la Banya) and thus may act more like an island than a typical continental site. Nevertheless, it has been maintained as a continental area in all the analyses. Other than this site, all continental sites are in wetlands or, in the case of two sites in S Morocco, in large palm or market-garden oases, where fresh water is readily available for birds. Other than in these two latter sites, all other continental ringing stations are located in coastal areas, either on the coastline itself or less than 10 km inland, or, as in the case of Sebes, 41 km inland on a reservoir on the Ebro river.

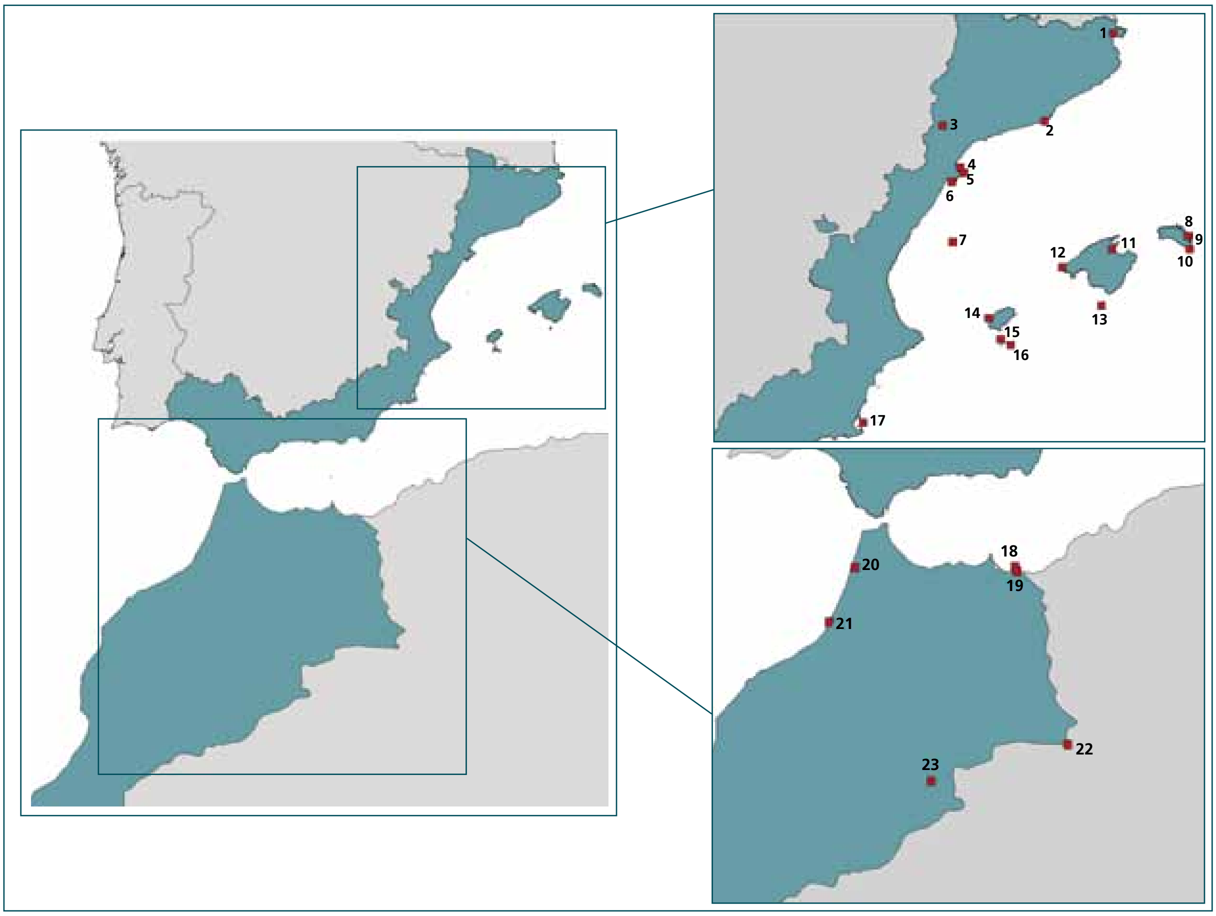


Figure 1. Location of the study sites (red squares). (For abbreviations of location numbers see table 1).

Although the Aiguamolls is treated here as a single site, this name in fact encompasses five different ringing stations all operating in one small area and each less than 10 km away from all the others and located in the same main wetland. The actual ringing site varied from year to year for logistical reasons. By contrast, the two ringing sites on Formentera –Can Marroig and La Mola– are initially described separately since they are situated c. 15 km apart, one on each side of the island; nevertheless, thereafter they are treated as just a single site (Formentera) given that the habitat is similar and due to the small sample size at La Mola, which prevents independent analysis.

Twelve ringing stations are situated on islands, of which 10 lie in the middle of the western Mediterranean either in the Balearic Islands or on the archipelago of Els Columbrets, 50-250 km off the Spanish coast and 230-370 km from N Africa. The other two insular sites lie close to the mainland: Illa Grossa is 2.5 km off the west coast of Murcia, SW Spain, while Las Chafarinas are 3.6 km north of the Mediterranean coast of Morocco. Most of these ringing sites are on small or very small islands (0.1-2.5 km^2), two are on the moderately large island of Formentera, the smallest of the four main Balearic Islands, while the two remaining sites are on the much larger islands of Mallorca and Menorca. These two latter sites are located in wetlands, while all the others are situated in drier areas usually dominated by low or sparse Mediterranean scrublands.

Study period

In order to cover most of the spring migration period, the study covered the months of March, April and May. Specifically, the data presented here is from a period of 90 days: 2 March to 30 May, although most sites were only operative for part of this period, usually the 30 days between 16 April and 15 May. This period coincides with the standard PPI study period, although for some sites data from several years exist that cover the entire 90 days or a large part of it (table 2). The period operated by each ringing station changes from one year to the next for logistical reasons such as the availability of ringers and budget. Overall, the maximum number of operative days (roughly 500 per pentad) were registered during the standard period (16 April to 15 May), although activity was also high during the first half of April, with more than 200 days available for each pentad (table 3). During the second half of both March and May, the number of operative days decreases to about 100 per pentad and to roughly 40-50 days during the first two weeks of March. The study period was best covered in Catalonia. Data is available for nearly the whole period for Els Columbrets, but the sample size is small outside the standard study period, particularly in March and late May. For the dry Balearics data is only lacking from the first half of March as the rest is well covered. Other than March, for which data is lacking from nearly the whole month, N Morocco, is fairly well covered. The wet Balearics is well covered during the standard period, but less so during the second half of March and the first third of April. For Las Chafarinas and S Morocco, data are only available for one third of the study period.

Field methods

At all sites, bird ringing took place following standardized mist-netting protocols (Bairlein, 1995). The number of nets varied considerably from site to site, but both number and location were constant for a given year and site. Generally, net location and extent varied little from year to year at a given site. Metres of net used at each site and the degree of variability are shown in table 1. Apart from in S Morocco, where a few clap-nets were also used for ground-foraging species, at all sites birds were only trapped using mist-nets. No tape-luring or any other artificial system for attracting birds was used at any site.

Nets remained open all day, except at Catalan sites from 2000 onwards, the year in which a protocol of net closure during the central hours of the day was put into practice. Accordingly, nets were opened three hours before sunset and closed six hours after dawn. At all sites nets remained open during the night. During operational hours, nets remained open other than during periods of very bad weather, particularly heavy rain and wind. Nets were checked at least once every hour.

All birds captured were weighed and measured before release. In some years and at some sites retraps were not processed or the data was unavailable at the time of analysis (table 2). Data taken for each bird included species, race (when known), age and sex, date and hour of capture, bird condition, wing length, third primary length, weight, fat and muscle score. All measures were taken following Bairlein (1995).

Dataset

During the 16 years of the project, a total of 202,107 birds were ringed and nearly 40,000 retrapped (table 4). This dataset is one of the largest available in SW Europe and includes information pertaining to 191 different species for a period of the annual cycle that had been largely overlooked before the start of the PPI.

Table 1. Main features of the study sites. 'Aiguamolls' includes several locations of similar habitat that are very close to each other and so are here treated as a single study site. The two sites from Formentera (Can Marroig and la Mola) lie some distance apart (c. 15 km), but share similar habitat and so their data has been pooled and used as if belonging to a single ringing site (Formentera).

Number	Site name	Area	Situation	Size (km^2)	Coordinates	Main habitat	Water	Nets (m)
1	Aiguamolls	Catalonia	Continent		42° 17′ N - 03° 07′ E	Wetland (reedbeds,tamarix, brambles)	Lagoon	180-250
2	Llobregat	Catalonia	Continent		41° 17′ N - 02° 04′ E	Wetland (reedbeds, tamarix, riverine forest)	Lagoon	180-251
3	Sebes	Catalonia	Continent		41° 14′ N - 00° 31′ E	Wetland (reedbeds, tamarix)	Reservoir	240
4	Canal Vell	Catalonia	Continent		40° 45′ N - 00° 47′ E	Wetland (reedbeds, tamarix, bushes)	Lagoon	240
5	Alfacada	Catalonia	Continent		40° 41′ N - 00° 50′ E	Wetland (reedbeds)	Lagoon	200
6	Punta de la Banya	Catalonia	Continent		40° 35′ N - 00° 39′ E	Mediterranean scrub & pine forest	No	180
7	Columbrets	Columbrets	Island	0.14	39° 53′ N - 00° 40′ E	Mediterranean scrub	No	36
8	Illa de Colom	Balearics (dry)	Island	0.70	39° 57′ N - 04° 16′ E	Mediterranean scrub & pine forest	No	250
9	Albufera d'Es Grau	Balearics (wet)	Island (Menorca)	694.39	39° 57′ N - 04° 15′ E	Wetland (tamarix, matorral)	Lagoon	200
10	Illa de l'Aire	Balearics (dry)	Island	0.24	39° 48′ N - 04° 17′ E	Mediterranean scrub & tamarix	No	250
11	Albufera d'Alcúdia	Balearics (wet)	Island (Mallorca)	3,620.42	39° 48′ N - 03° 06′ E	Wetland (reedbeds, tamarix)	Lagoon	200
12	Dragonera	Balearics (dry)	Island	2.52	39° 35′ N - 02° 20′ E	Mediterranean scrub, pine forest & fruit trees	No	200
13	Cabrera	Balearics (dry)	Island	11.53	39° 08′ N - 02° 56′ E	Mediterranean scrub, pine forest & fruit trees	No	250
14	Conillera	Balearics (dry)	Island	0.72	38° 59′ N - 01° 13′ E	Mediterranean scrub	No	180
15	Formentera (Can Marroig)	Balearics (dry)	Island (Formentera)	83.20	38° 44′ N - 01° 24′ E	Mediterranean scrub, pine forest & fruit trees	No	180
16	Formentera (la Mola)	Balearics (dry)	Island (Formentera)	83.20	38° 40′ N - 01° 33′ E	Mediterranean scrub, pine forest & fruit trees	No	250
17	Illa Grosa		Island	0.17	37° 44′ N - 00° 42′ W	Mediterranean scrub	No	180
18	Chafarines	Chafarines	Island	0.52	35° 11′ N - 02° 26′ W	Mediterranean scrub	No	180
19	Kerbacha	N Morocco	Continent		35° 06′ N - 02° 23′ W	Wetland (tamarix)	River	240
20	Larache	N Morocco	Continent		35° 10′ N - 06° 06′ W	Wetland (reedbeds, tamarix)	River	180
21	Sidi Bou Rhaba	N Morocco	Continent		34° 14′ N - 06° 41′ W	Wetland (reedbeds, tamarix, matorral)	Lagoon	180
22	Fguig	S Morocco	Continent	6.65	32° 06′ N - 01° 14′ W	Large oasis with palms, fruit trees & orchards	Irrigation	100
23	Jorf	S Morocco	Continent	6.57	31° 27′ N - 04° 21′ W	Large oasis with palms, fruit tress & orchards	Irrigation	78-93

Table 2. Periods of operation by site and by year (days with effective operation are shown in brackets; bold type denotes that retraps are not available).

	Site	1992	1993	1994	1995	1996	1997	1998
1	Aiguamolls		16/4-15/5(30)	16/4-15/5(30)	16/4-15/5(30)	16/4-15/5(30)	16/4-15/5(30)	1/4-30/5(60)
2	Llobregat							
3	Sebes						17/3-15/4(30)	
4	Canal Vell					16/4-15/5(30)	16/4-15/5(30)	16/4-15/5(28)
5	Alfacada							
6	Punta de la Banya		16/4-15/5(30)					
7	Columbrets			13/4-15/5(32)	12/4-10/5(29)	10/4-8/5(24)	16/4-20/5(33)	22/4-21/5(24)
8	Illa de Colom							
9	Albufera d'Es Grau							
10	Illa de l'Aire		16/4-15/5(29)	16/4-15/5(30)	1/4-15/5(45)	**17/3-15/5(60)**	17/3-15/5(60)	17/3-16/5(61)
11	Albufera d'Alcúdia					16/4-15/5(30)		
12	Dragonera					7/5-30/5(24)	17/4-25/5(34)	
13	Cabrera	22/4-30/5(38)	16/4-15/5(30)	16/4-30/5(45)	28/3-15/5(49)	20/4-30/5(41)	16/4-26/5(40)	25/3-21/5(58)
14	Conillera							
15	Formentera (Can Marroig)							
16	Formentera (la Mola)		**16/4-15/5(30)**					
17	Illa Grosa							
18	Chafarines							
19	Kerbacha			16/4-15/5(30)		3/4-23/5(40)	25/4-7/5(13)	
20	Larache							
21	Sidi Bou Rhaba							
22	Fguig							
23	Jorf							

Data analysis and presentation of results

Selected species

The present work is based on the results obtained for a set of 30 species (table 5), all of which are dealt with extensively in a separate species account. These 30 species correspond to the birds with the largest available sample sizes after excluding certain species for various reasons: Sardinian Warbler and four finch species (Serin, Greenfinch, Linnet and Goldfinch) were all excluded because their abundant breeding populations in the study area would have masked migratory patterns and posed serious analytical problems. Another species not included despite a good sample size is the Reed Bunting, since it mostly winters in the region and leaves very early. The selection of species includes 26 trans-Saharan migrants, two species that winter north of the Sahara (Song Thrush and Robin) and two with mixed migratory patterns (Blackcap and Chiffchaff; table 5).

Site aggregations

To facilitate the analysis, the different sites were grouped into seven main areas (table 1). Catalonia includes all ringing stations in this region of NE Spain, all of which are continental and situated in wetlands (except for La Punta de la Banya). Els Columbrets, an isolated group of islands far off the African coast, forms an area by itself and the available dataset covers many years and a large part of the migratory period (table 3). The Balearic sites have been split into two main areas, named dry Balearics and wet Balearics, although they could equally well have been named 'small' and 'large' since they differ markedly both in size and habitat. The wet Balearics includes the two sites located in the main wetlands of Mallorca and Menorca, the largest and the third largest of the Balearic islands, respectively. The available data from these sites, which are very distinct and thus merit their own group, are not very extensive (table 4). The dry Balearics include the rest of the Balearic sites, seven in all, which are all found on very small or quite small islands and in dry habitats, mostly Mediterranean scrubland. Except for the first half of March, data are plentiful and cover the entire migratory period. Las Chafarinas includes only data from this tiny island off the north coast of Morocco and only 10 km north of Kerbacha. Only two months of data are available, although the site is very distinct in terms of its geographical location and habitat. N Morocco includes three sites from Morocco: two on the Atlantic coast and the other on the Mediterranean. All three ringing stations are in wetlands and the available data

1999	2000	2001	2002	2003	2004	2005	2006	2007
1/4-30/5(60)	1/4-30/5(60)	2/3-30/5(88)	2/3-30/5(86)	2/3-30/5(86)	2/3-30/5(90)	9/3-30/5(81)	2/3-30/5(88)	2/3-30/5(86)
							8/3-30/5(84)	2/3-30/5(89)
16/4-15/5(30)	16/4-15/5(30)	16/4-15/5(30)	16/4-15/5(29)	16/4-15/5(30)	17/4-15/5(29)	17/3-15/5(57)	17/3-15/5(60)	17/3-15/5(58)
							16/4-30/5(45)	17/3-15/5(56)
21/4-17/5(27)	19/4-29/5(30)	4/4-16/5(39)	17/4-14/5(25)	17/4-13/5(23)	14/4-12/5(27)	13/4-11/5(29)	12/4-10/5(27)	2/3-22/5(81)
								16/4-15/5(30)
		16/4-30/4(15)	12/3-10/4(28)			16/4-15/5(30)	16/4-15/5(30)	
1/4-15/5(45)	1/4-15/5(45)	1/4-15/5(45)	1/4-15/5(45)	1/4-15/5(44)	1/4-15/5(45)	1/4-15/5(44)	1/4-15/5(45)	1/4-15/5(45)
					16/4-14/5(29)	16/4-15/5(30)	16/4-15/5(30)	16/4-15/5(30)
20/4-13/5(24)	20/4-18/5(29)	15/4-13/5(29)	18/4-17/5(30)	19/3-17/5(56)	20/3-5/5(43)	19/3-7/5(47)	18/3-13/5(49)	17/3-15/5(56)
				16/4-15/5(30)	21/4-20/5(30)	16/4-15/5(20)	**18/4-15/5(28)**	17/4-15/5(29)
				16/4-15/5(29)	17/4-14/5(27)	16/4-15/5(30)	16/4-15/5(25)	16/4-15/5(29)
								1/4-2/5(32)
	16/4-14/5(29)	19/4-15/5(27)						
					1/4-5/5(23)			
30/3-30/5(59)	27/3-29/5(56)							
						1/4-30/4(19)		
							1/4-30/4(23)	

are sufficient to cover both April and May well, but not March. The last group is S Morocco, which includes data from two sites in SE Morocco just north of the Sahara desert. Both are situated in quite large palm oases with a profusion of market gardens and fruit trees; data are scarce but represent the only available dataset from the region. Illa Grossa is not included in any of the previous areas since its geographical situation is very different. In addition, its small sample size (table 4) prevented it from being given its own group.

Recovery maps

Recovery maps are included in order to help envisage the main migratory routes. Recoveries are limited to distances greater than 5 km and to birds ringed or recovered in the study area: Morocco (north of 28º), Els Columbrets, the Balearics and S and E coastal provinces of Spain (fig. 1). Only birds ringed or recovered in this area between March and May have been included. Recoveries are divided into two groups: direct recoveries (shown as red lines on the maps) and the rest (blue lines). Direct recoveries are defined as: 1) birds ringed in the study area (March to May) and recovered between March and July of the same year; 2) birds ringed outside the study area between March and May and recovered during these same months of the same year within the study area; or 3) birds ringed south of 23ºN and subsequently recovered in the study area between March-May. Round (non-direct) and square (direct) symbols indicate the ringing site. Maps were produced with ArcView 3.2/3.3 (ESRI inc.) using the Mercator projection, which is the most convenient projection for mid-latitudes, which is where most recoveries took place.

Temporal and geographical recovery patterns

The mean bearings (loxodrome), latitudes and longitudes of the recoveries were calculated for three different areas (the Balearic Islands/Els Columbrets, Catalonia and the rest of Spain) in order to detect possible geographical differences in the direction of passage. Moreover, to elucidate possible differences between populations during passages periods, we studied the relationship between the date of capture in the study area and the latitude (N) of the ringing/recovery site in Europe.

To undertake these calculations only birds recovered or ringed to the north of Spain (more than 42.85ºN) were included; both direct and non-direct recoveries were used. Only species with more than 20 available recoveries were included in the analyses. Direction was always calculated towards the presumed origin of the birds (*i.e.* the site of capture situated to the north of Spain) and longitudes and latitudes also refer to the ringing/recovery site placed to the north of Spain. Lines connecting ringing and recovery sites do not necessar-

Table 3. Total number of days operated in each pentad and area. The totals for 'All sites' are higher than the sum of all the sites named here because data from Illa Grossa are also included. Pentads are standardized following Berthold (1973). Pentad 13 begins on 2 March and pentad 30 ends on 30 May.

Area	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia	33	40	44	64	67	69	82	82	79	157	160	159	159	159	159	61	61	60
Columbrets	5	5	5	4	5	5	7	11	29	51	68	68	64	64	41	13	3	
Balearics (dry)				30	41	46	97	99	98	207	229	239	227	225	224	48	31	21
Balearics (wet)			5	5	5	4	4	5		20	19	20	15	15	15			
Chafarinas										7	10	10	10	9	9			
N Morocco						7	14	15	16	22	24	25	28	20	18	14	13	8
S Morocco							10	8	5	5	7	7						
All sites	38	45	54	103	118	131	219	225	232	474	522	533	505	492	466	136	108	89

ily represent the routes followed by the birds, above all when recoveries are non-direct. However, we assume that mean directions, longitudes and latitudes calculated here mostly reflect differences in breeding origin since only birds captured to the north of Spain were used. Likewise, the probability of including birds displaced longitudinally due to differences between the main autumn and spring directions are expected to be similar for all three different areas. Differences between areas in terms of mean directions, longitudes and latitudes were considered to be significant when their respective confidence intervals (95%) did not overlap. The temporal relationship between time of passage and latitude was statistically tested using a linear regression model.

Geographical differences in intensity of passage

Two different indexes were used to indicate possible differences between study sites in terms of the intensity of passage: the mean daily number and the frequency of captures. The analyses were limited to the standard period for all sites (16 April to15 May), except for S Morocco (Fguig and Jorf), where, due to data availability, it was shifted to 1 to 30 April, and to 16 April to 2 May in the case of Illa Grossa. Only sites that operated during most of these periods were used. The mean daily number of captures was calculated as the total number of first captures at each site divided by the number of

Table 4. Ringing totals by site and year (number of retraps in brackets; bold type denotes that retraps are not available).

	Site	1992	1993	1994	1995	1996	1997	1998	1999
1	Aiguamolls		829(135)	1,930(142)	1,355(590)	3,561(429)	1,860(373)	3,791(627)	3,481(762)
2	Llobregat								
3	Sebes						555(94)		
4	Canal Vell					597(56)	716(67)	641(53)	778(72)
5	Alfacada								
6	Punta de la Banya		1,687(526)						
7	Columbrets			1,856(41)	2,507(40)	1,265(48)	935(20)	1,182(229)	1,360(146)
8	Illa de Colom								
9	Albufera d'Es Grau								
10	Illa de l'Aire		1,604(629)	2,594(728)	2,943(1,091)	5,258(1,397)	**5,818(0)**	4,522(1478)	3,265(399)
11	Albufera d'Alcúdia					384(184)			
12	Dragonera					430(64)	703(194)		
13	Cabrera	2,608 (144)	2,025(136)	3,724(526)	3,852(875)	3,000(656)	2,590(502)	3,330(617)	1,603(187)
14	Conillera								
15	Formentera (Can Marroig)								
16	Formentera (la Mola)		**1,388(0)**						
17	Illa Grosa								
18	Chafarines								
19	Kerbacha			1,848(581)		1,171(190)	212(28)		
20	Larache								
21	Sidi Bou Rhaba								663(74)
22	Fguig								
23	Jorf								
Total		2,608(144)	7,533(1,426)	11,952(2,018)	10,657(2,596)	15,666(3,024)	13,389(1,278)	13,466(3,004)	11,150(1,640)

operative days (note that the number of nets may differ between sites). The relative frequency was calculated by dividing the total number of first captures of a given species at a given site by the total of all species captured at that site (excluding sedentary ones). Then, a value of 100 was awarded to the highest frequency and 0 to the lowest, the rest of values being calculated relative to this scale.

Phenology

The overall pattern of passage was calculated for the entire study area except S Morocco. Since periods of operation changed from site to site and year to year, we undertook calculations on the basis of the number of individuals captured in relation to the total number of operative days in each pentad. Therefore, the total number of individuals trapped in each pentad (all sites and years combined) was divided by the total number of ringing days in each pentad. Results were then converted into a percentage of captures in each pentad in relation to the total. Median dates of passage are also given. Medians were calculated using the ratio of the number of first captures on any given day divided by the total number of ringing sessions undertaken in that day. Depending on the sample size and the degree of age or sexual dimorphism, phenology is also given according to age or sex or both.

Since the sampling intensity was uneven over the season and between areas (cf. table 3), the possibility of generating a number of spurious results could not be ruled out, especially since data from March was largely unavailable from N Morocco and non-existent in the first half of March from the Balearics. Nonetheless, the sample sizes are generally quite large and we believe that the main passage patterns are reasonably accurate. Nevertheless, to detect possible phenological differences between the main regions and any flaws in these analyses, passage patterns were also calculated independently for Catalonia, the Balearics/Els Columbrets and N Morocco and are discussed in the texts when appropriate. A further concern over the phenological patterns involves the inclusion of local breeding birds in the datasets. Fortunately, most of the target species do not breed in the study area or only do so in small numbers and thus hardly affect the main patterns. In those few species in which local breeding birds are more numerous, phenological patterns have been calculated using only data from sites where the species is fully migratory or only breeds in very low numbers. In these cases, the particular procedure is detailed in the corresponding species account.

In the case of three species with a large sample and marked sexual dimorphism in size (Chiffchaff, Willow Warbler and Wood Warbler), graphs show the frequency distribution of the third primary length in fortnightly periods. The marked bimodality in third primary length

2000	2001	2002	2003	2004	2005	2006	2007	Total
2,824(774)	2,122(578)	2,506(501)	1,943(666)	3,258(960)	2,905(885)	1,610(755)	2,668(1,002)	36,643(9,179)
						1,931(449)	2,477(645)	4,408(1,094)
								555(94)
888(97)	750(115)	1,144(194)	767(253)	1,266(290)	1,215(372)	1,411(597)	2,093(1,063)	12,266(3,229)
						624(46)	1,429(170)	2,053(216)
								1,687(526)
1,730(114)	2,921(85)	3,237(88)	1,756(186)	1,982(23)	2,313(149)	1,429(100)	3,648(159)	28,121(1,428)
							810(212)	810(212)
	481(22)	761(341)			684(126)	414(109)		2,340(598)
2,440(975)	3,966(1,314)	4,045(1,263)	2,039(587)	3,986(1,644)	2,175(496)	3,051(985)	2,788(881)	50,494(13,867)
								384(184)
				819(0)	1,031(86)	277(43)	1,396(110)	4,656(497)
1,195(167)	1,682(238)	1,544(143)	2,218(245)	1,368(203)	1,848(106)	1,702(240)	3,651(517)	37,940(5,502)
			981(187)	886(57)	764(65)	**646(0)**	1,040(25)	4,317(334)
			986(61)	956(57)	1,181(21)	872(70)	1,145(21)	5,140(230)
								1,388(0)
							1,548(120)	1,548(120)
654(130)	382(102)							1,036(232)
								3,231(799)
				418(44)				418(44)
1,064(187)								1,727(261)
					359(0)			359(0)
						586(0)		586(0)
10,795(2,444)	12,304(2,454)	13,237(2,530)	10,690(2,185)	14,939(3,278)	14,475(2,306)	14,553(3,394)	24,693(4,925)	20,2107(38,646)

in these species allows us to detect accurately the seasonal variation in the presence of the two sexes.

Descriptive biometrics

In order to facilitate comparison with other available published data, means for each of the seven areas were calculated for a set of four variables: wing length, third primary length, body mass and fat score. Data are presented in a separate table with standard deviation, ranges and sample sizes.

Site-related differences in body mass and fat

Means and confidence intervals (95%) were calculated for body mass and fat for each site. The analysis is limited to the standard period for all sites (16 April to 15 May), except for S Morocco (1-30 April) and Illa Grossa (16 April to 2 May). Only sites that operated during all or most of these periods and with a minimum sample of five birds were used. Differences between sites were considered to be significant when their respective confidence intervals did not overlap.

Geographical and temporal variation in the main biometric parameters

To describe variations over time and between the seven study areas we prepared graphs showing means and standard errors for each area and pentad for a set of four variables: third primary length, body mass, fat score and physical condition. Only data from pentads with a minimum sample size of three individuals are shown in the graphs. Physical condition was calculated as body mass/third primary length. We tested for differences between areas and in relation to timing using interactive ANCOVA models, setting each biometric as the dependent variable, area as factor and pentad as a covariable. When interaction was non-significant, we set models without interaction and if the pentad had no effect we ran simple ANOVA models. Post-hoc tests were conducted to detect differences between pairs by applying the Bonferroni correction. To test for temporal trends in each of the four variables within each main study area we performed Pearson correlations (of each variable against the pentad). Appendix 1 shows mean, SD and sample size for each species, pentad and variable (third primary length, body mass and fat).

Stopover

Stopover behaviour was analysed for only six of the areas (S Morocco was omitted since no retraps were available). Different variables were used in order to help understand stopover and its geographical variation. To discern differences in body condition we calculated mean body mass for each area and birds' capture status: 1) birds not retrapped; 2) first capture of retrapped birds; and 3) final capture of retrapped birds. By 'retrapped bird' we mean those birds captured on at least two different days at the same site and in the same year (retraps from the same day are not taken into account). We also calculated average minimum stopover length (the number of days between first and final capture) for each area and the percentage of retraps in the sample. The percentage of retraps and mean body mass and minimum stopover length with their respective confidence intervals (95%) are shown in the graphs in the same figure. Only data from areas with a minimum of two individuals were included.

We also calculated mean fuel deposition rates (g/day) for each area as the difference between the body mass at first and final captures divided by the number of days between the captures. The fuel deposition rates were estimated for all retraps, and for retraps of more than one day. The latter calculation was made in order to avoid the effects of loss in body mass shown by many birds the day after first capture (Schaub & Jenni, 2000; Schwilch & Jenni, 2001). Data are shown in a separate table, along with sample sizes and confidence intervals (95%).

The presence of breeding birds may have affected the calculations of stopover behaviour; however, as commented above, only a few species breed at the study sites and often only in very small numbers compared to those that pass through on passage. Any potential effect of local breeding birds is commented upon in the text. Given that the minimum sampling period extended for *c.* 30 days at many sites and in many years, in all the analyses we limited the retraps to those occurring less than 30 days after the first capture. Body mass was not corrected for time of day. Differences between areas in mean stopover length and in mean body mass were considered to be significant when their respective confidence intervals (95%) did not overlap. Fuel deposition rates were considered significant when confidence intervals (95%) did not include 0.

Statistical treatment

Throughout the species accounts we use the results of the various tests of significance described here to support our findings. The existence of differences is only mentioned explicitly when these are significant, although to avoid cluttering the text we do not necessarily indicate this in the accounts. The results of the main statistical tests are summarised in Appendix 2.

Table 5. Total number of birds ringed for the 30 species analysed in each area during the whole study period (the number of retraps is shown in brackets, except for S Morocco where retraps were not processed).

Species	Catalonia	Columbrets	Balearics (dry)	Balearics (wet)	Chafarinas	N Morocco	S Morocco	Total
Streptopelia turtur	16 (0)	514 (17)	907 (82)	11 (1)	1 (0)	0 (0)	0	1,450 (101)
Merops apiaster	138 (6)	29 (1)	637 (11)	1 (0)	0 (0)	18 (0)	0	824 (18)
Upupa epops	86 (11)	72 (1)	462 (109)	12 (1)	0 (0)	0 (0)	3	642 (122)
Riparia riparia	637 (11)	12 (1)	64 (1)	15 (0)	0 (0)	1 (0)	3	732 (13)
Hirundo rustica	7,890 (93)	435 (13)	1,815 (37)	467 (1)	9 (0)	130 (0)	218	11,050 (144)
Delichon urbicum	134 (0)	52 (0)	243 (9)	34 (0)	0 (0)	3 (0)	14	436 (9)
Anthus trivialis	55 (4)	252 (16)	705 (95)	9 (0)	3 (0)	0 (0)	5	1,034 (115)
Motacilla flava	222 (21)	156 (1)	236 (9)	6 (0)	0 (0)	4 (0)	61	685 (31)
Erithacus rubecula	1,942 (1,452)	991 (64)	8,016 (3,539)	95 (100)	0 (0)	8 (1)	2	11,266 (5,175)
Luscinia megarhynchos	1,585 (1,651)	1,823 (154)	2,280 (1,185)	73 (40)	14 (3)	268 (129)	1	6,117 (3,163)
Phoenicurus phoenicurus	1,205 (476)	2,018 (119)	6,656 (1,469)	16 (0)	11 (1)	34 (3)	21	10,074 (2,075)
Saxicola rubetra	353 (28)	139 (6)	2,019 (134)	12 (0)	9 (1)	5 (0)	18	2,561 (169)
Turdus philomelos	247 (27)	120 (0)	436 (22)	19 (4)	0 (0)	4 (0)	0	833 (54)
Locustella naevia	342 (36)	98 (4)	311 (56)	3 (0)	1 (0)	13 (0)	0	770 (96)
Acrocephalus schoenobaenus	471 (75)	46 (0)	137 (14)	18 (1)	2 (1)	58 (7)	11	745 (98)
Acrocephalus scirpaceus	9,852 (1,879)	328 (28)	760 (194)	42 (9)	20 (8)	1,234 (275)	85	12,321 (2,393)
Acrocephalus arundinaceus	947 (526)	8 (1)	75 (11)	60 (14)	0 (0)	91 (20)	0	1,181 (572)
Hippolais icterina	48 (14)	53 (7)	502 (154)	3 (0)	1 (0)	10 (1)	0	617 (176)
Hippolais polyglotta	673 (132)	719 (27)	801 (126)	1 (0)	400 (97)	192 (20)	6	2,795 (402)
Sylvia cantillans	681 (110)	775 (31)	2,253 (324)	11 (0)	22 (4)	68 (19)	4	3,858 (491)
Sylvia communis	1,187 (195)	1,709 (83)	6,340 (1,129)	26 (3)	43 (8)	55 (11)	3	9,387 (1,434)
Sylvia borin	1,562 (215)	1,614 (86)	5,820 (649)	55 (2)	49 (9)	551 (40)	9	9,672 (1,003)
Sylvia atricapilla	4,380 (867)	746 (39)	4,818 (784)	154 (14)	5 (0)	296 (20)	32	10,469 (1,725)
Phylloscopus bonelli	145 (25)	304 (21)	771 (131)	2 (0)	10 (2)	12 (0)	2	1,276 (181)
Phylloscopus sibilatrix	197 (66)	176 (23)	813 (111)	49 (19)	9 (3)	50 (13)	1	1,296 (235)
Phylloscopus collybita	2,137 (713)	1,081 (76)	4,452 (923)	136 (49)	6 (2)	85 (2)	45	7,966 (1,768)
Phylloscopus trochilus	9,103 (997)	9,663 (346)	33,947 (4,942)	371 (37)	269 (38)	553 (66)	93	54,704 (6,443)
Muscicapa striata	271 (39)	1,106 (98)	3,439 (218)	27 (5)	45 (10)	36 (3)	0	4,939 (373)
Ficedula hypoleuca	1,838 (488)	724 (50)	5,141 (942)	102 (1)	9 (0)	120 (30)	89	8,042 (1,511)
Lanius senator	235 (75)	852 (75)	1,489 (346)	16 (2)	14 (2)	11 (0)	53	2,701 (503)

Species accounts

Turtle Dove
Streptopelia turtur

Raül Escandell

Range

The Turtle Dove breeds in N Africa and most of Europe (apart from Scandinavia and Ireland) and eastwards to central Asia (Cramp, 1985). It is a long-distance migrant that winters in sub-Saharan Africa, from Senegal and Guinea to Sudan and Ethiopia, and as far south as northern Ghana and northern Cameroon (Cramp, 1985). It breeds in very low numbers at some ringing sites, although the vast majority of captures are of migrants.

Migratory route

Many recoveries are of birds ringed on spring passage in the study area and recovered in late summer or autumn either further west (W and SW Iberian Peninsula) or further east (Italy; fig. 1). However, a few northern recoveries (Belgium and Netherlands) and one from sub-Saharan Africa suggest that SW-NE movements are the norm during spring migration and follow a similar axis of movement to autumn (Cramp, 1985; Zwarts et al., 2009), although apparently somewhat more to the east (Telleria et al., 1999; Wernham et al., 2002).

The species is mostly trapped on islands (fig. 2), particularly the smallest and most isolated, indicating some attraction factor, but also indicating that passage across the Mediterranean Sea is common.

Phenology

The first birds pass through the study area in early April and numbers then increase steadily, peaking during early May and decreasing rapidly from mid-May onwards (fig. 3). The overall pattern of passage is similar to that reported in NW Africa and the Mediterranean region (Cramp, 1985; Morgan & Shirihai, 1997; Thévenot et al., 2003; Zwarts et al., 2009). Phenological differences between the main study areas are inappreciable. The median date of passage when analyzing the standard period (16 April-15 May) is identical to that reported in the C Mediterranean (1 May; Rubolini et al., 2004).

Phenological differences between sexes are practically inexistent, although the median date of passage of second-year birds takes place 3-4 days later than in adults (fig. 3). The lack of sexual differences agrees with reports from the C Mediterranean (Rubolini et al., 2004).

Biometry and physical condition

Mean values for wing lengths vary from 171.7 in Catalonia to 174.5 on Els Columbrets (table 1). In general, these values are lower than those reported in the C Mediterranean (mean 177.4; n = 115; Spina et al., 1993), where a greater proportion of larger birds from more northern areas (Cramp, 1985) seems to occur. Third primary lengths decrease with time in the dry Balearics, but not significantly so on Els Columbrets (fig. 6). This trend may reflect the later passage of second-year birds or the differential migration of birds of different origin. In Italy, birds increase in size as the season progresses (Spina & Volponi, 2008).

Mean body mass varies from 126.2 in the wet Balearics to 132.5 in Catalonia. Mean mass on Els Columbrets/Balearics distinctly higher than in the C Mediterranean (122.6, n = 102; Spina et al., 1993), probably reflecting the larger stretches of sea and desert that have to be crossed by birds trapped in this latter area. Body mass in La Camargue, S France (mean 125.0, n = 48; Cramp, 1985), is slightly lower than in Catalonia and insular sites. Birds tend to be larger and heavier on Els Columbrets than in the dry Balearics, although the average fat is higher in the latter area (figs. 6, 8, 9). Overall, however, body mass does not show any marked differences in the western Mediterranean.

Body mass and fat do not show any clear temporal pattern, but physical condition increases with time and third primary length decreases. In Italy, body mass has been reported to increase seasonally during May (Spina & Volponi, 2008).

Stopover

The frequency of retraps is very low (fig 5), suggesting a large turnover of birds. Using the whole dataset, birds show significant negative fuel deposition rates in the dry Balearics, although a positive but not significant trend is observed when analysing retraps of more than one day (table 2).

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	13	171.7 ± 5.0 (165.0-182.0)	123.1 ± 3.5 (117.0-128.0)	132.5 ± 10.0 (115.0-147.4)	1.0 ± 0.9 (0-2)
Columbrets	315	174.5 ± 4.7 (161.0-183.0)	126.0 ± 3.9 (116.0-137.5)	132.4 ± 16.6 (87.4-182.0)	0.8 ± 0.7 (0-4)
Balearics (dry)	522	173.3 ± 4.8 (157.0-183.0)	125.2 ± 4.0 (115.0-138.0)	128.8 ± 14.3 (85.5-177.0)	1.0 ± 0.8 (0-6)
Balearics (wet)	11	172.7 ± 4.7 (166.0-180.5)	124.7 ± 4.2 (119.0-132.5)	126.2 ± 11.0 (108.9-142.6)	0.8 ± 0.8 (0-2)
Chafarinas	0				
N Morocco	0				
S Morocco	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		-2.38 ± 3.91 (6)	-3.46 ± 1.91 (22)			
Retraps >1 day		-0.74 ± 9.72 (2)	0.59 ± 2.36 (6)			

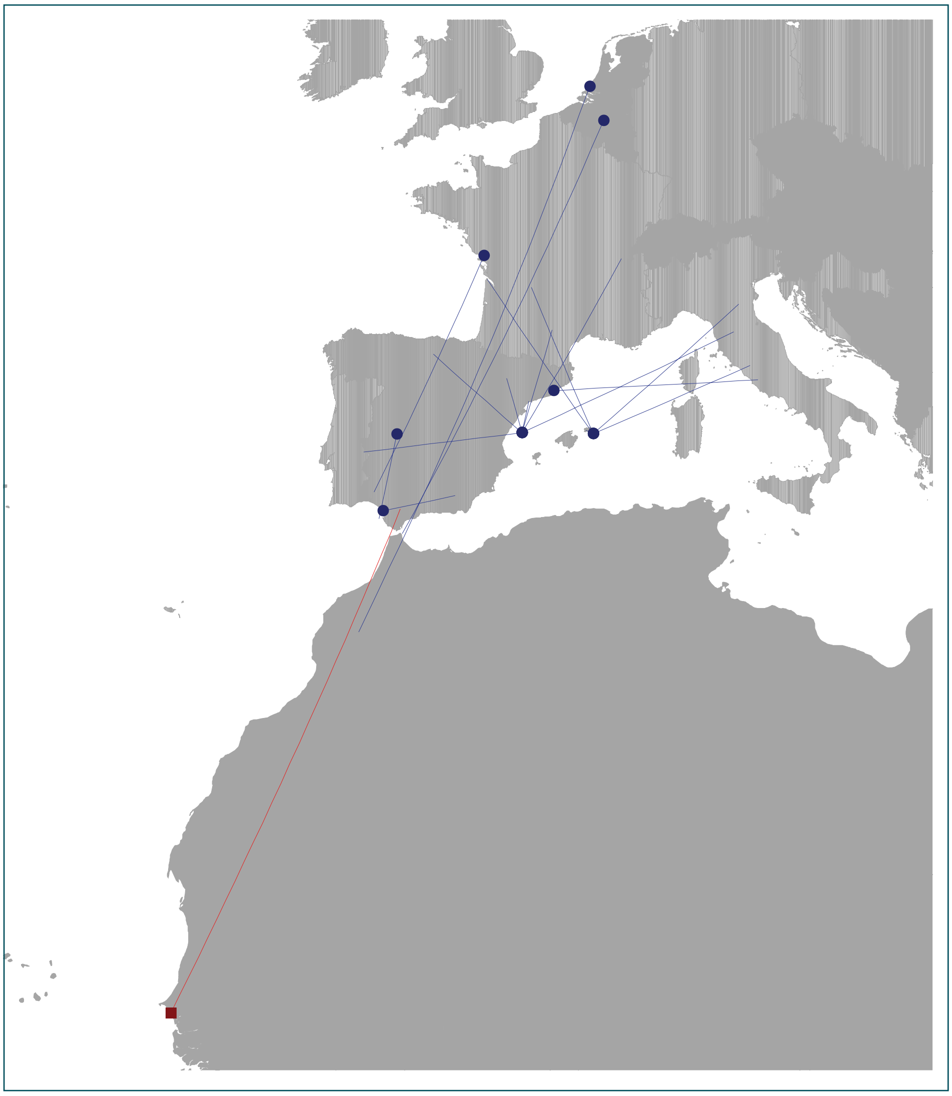


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

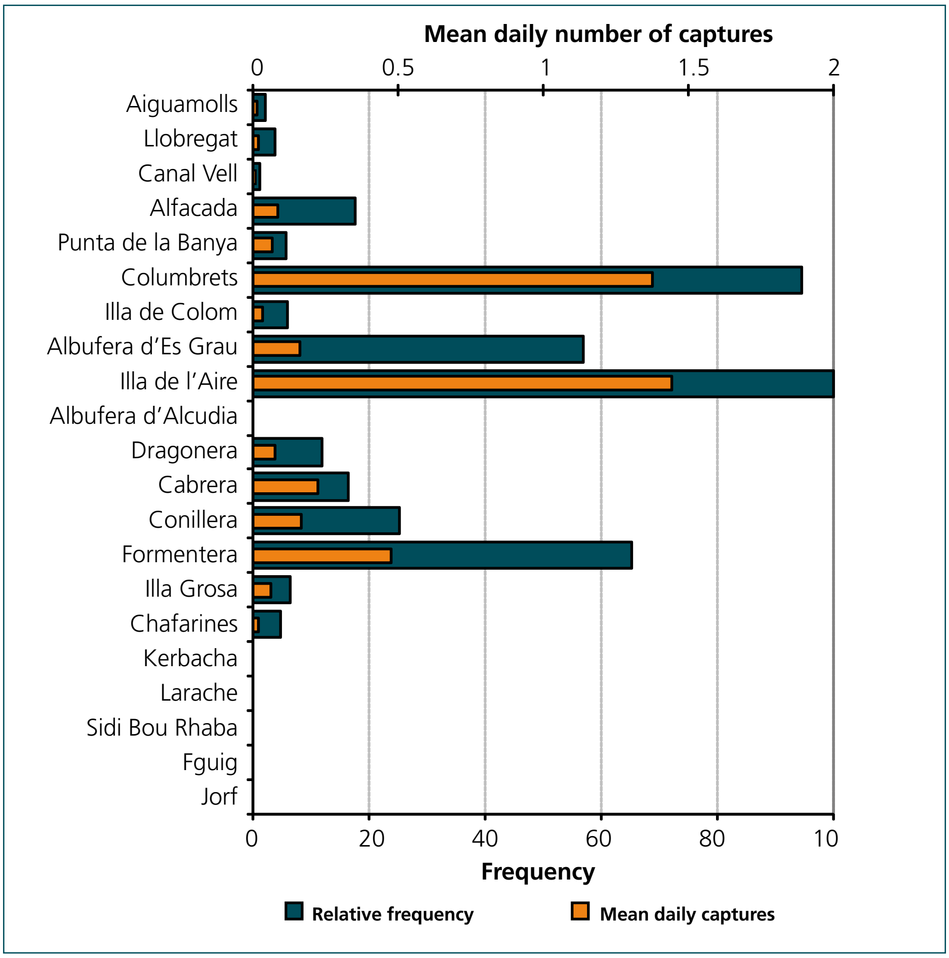


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

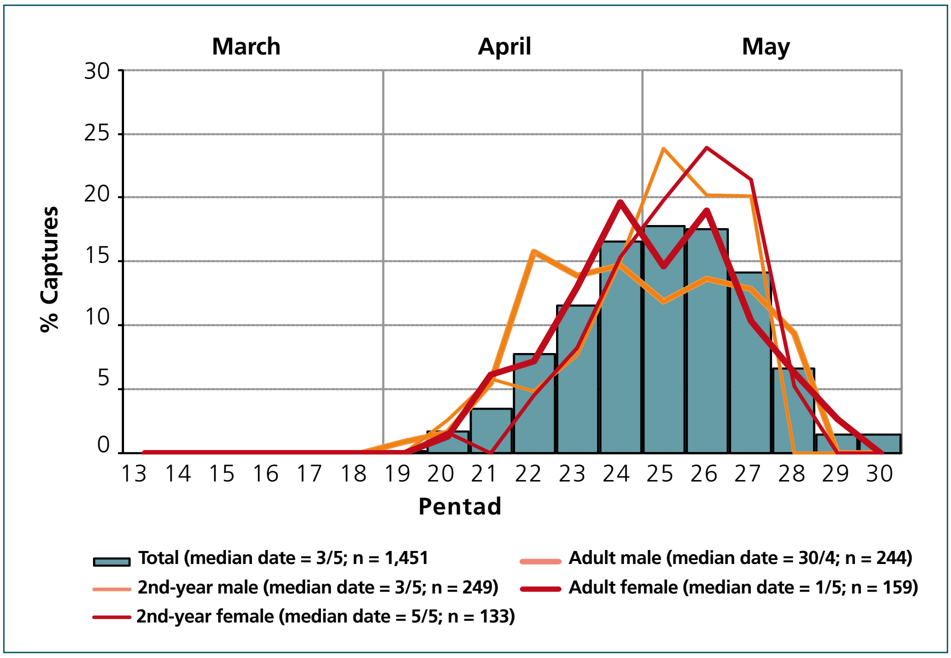


Figure 3. Frequency of captures during the study period.

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

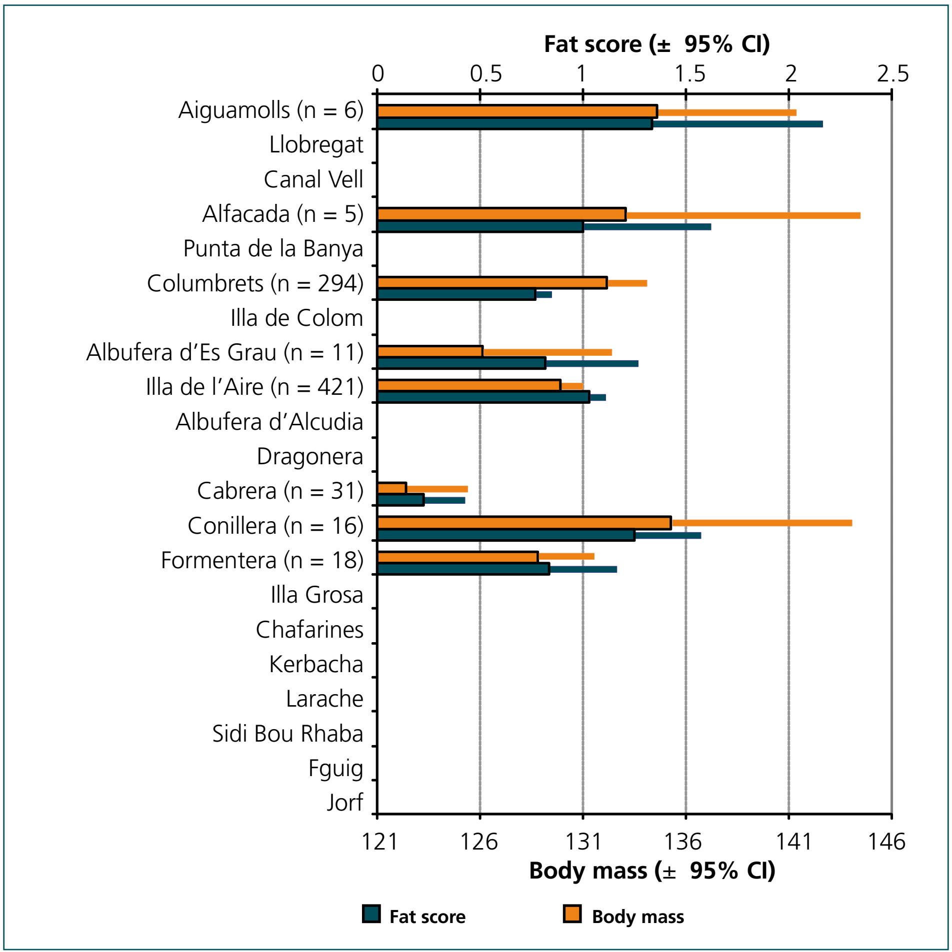
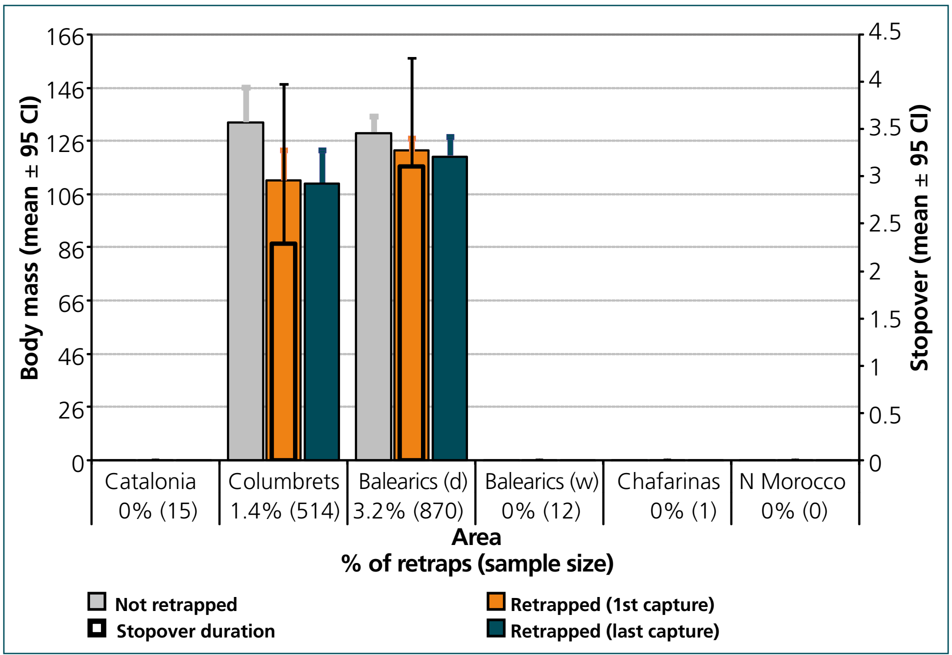


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



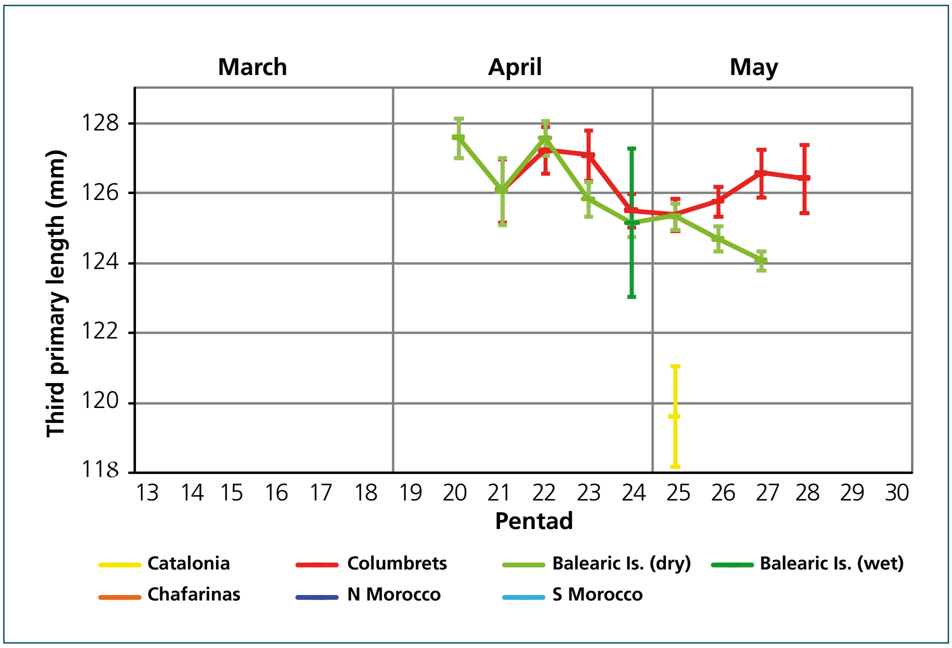


Figure 6. Temporal variation of third primary length according to area.

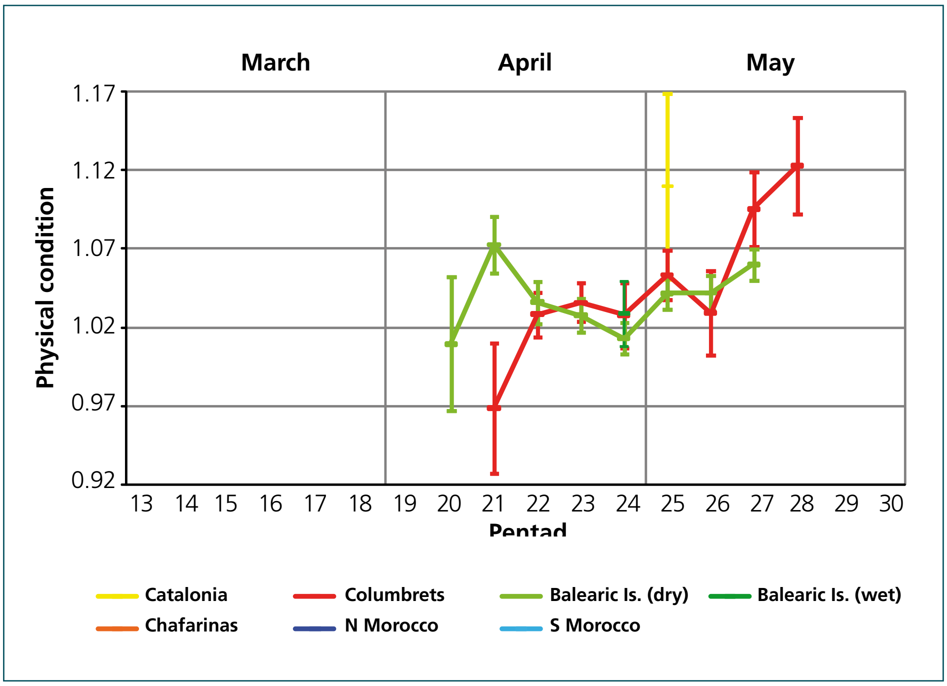


Figure 7. Temporal variation of physical condition according to area.

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

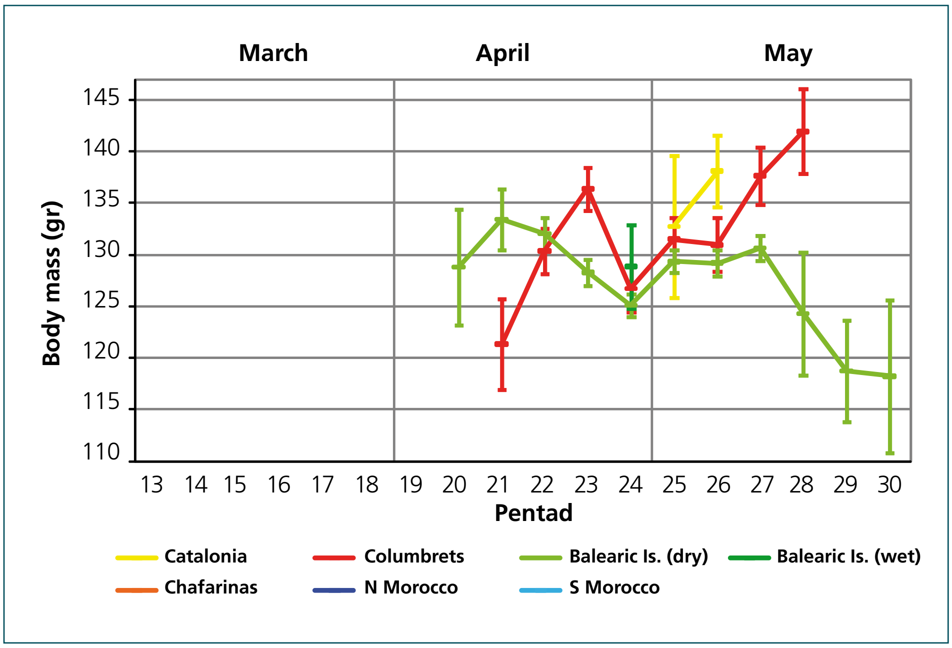
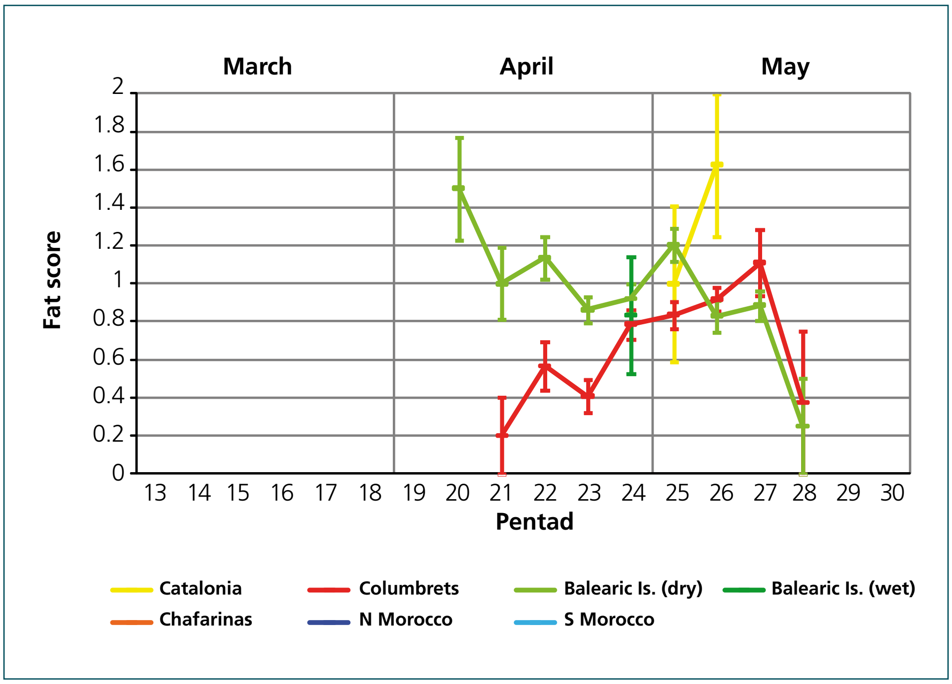


Figure 9. Temporal variation in fat score according to area.



Bee-eater
Merops apiaster

Carles Barriocanal & David Robson

Range

The Bee-eater is a trans-Saharan migrant that breeds at mid- and low-to-mid-latitudes in the W Palearctic (Snow & Perrins, 1998). Populations from W Europe winter in W Africa north of the Equator, while those from C and E Europe and Asia do so in E and S Africa south of the Equator (Hagemeijer & Blair, 1997). This species breeds at some study sites in Catalonia and on the larger Balearic Islands, although with the exception of Catalonia the vast majority of captures correspond to migrants.

Migratory route

Only two recoveries are available and both indicate a SW-NE axis of movement (fig. 1). One bird was ringed on Formentera in early May and recovered in E Germany two months later, while another was ringed in E Germany in July and recovered in Formentera the following spring. Both recoveries suggest that populations established in E Germany originate from birds wintering in W Africa and thus that not all C European birds winter in E and S Africa as is usually suggested (Hagemeijer & Blair, 1997; Cramp, 1998).

Most birds are trapped on Formentera (fig. 2) where conditions seem to be optimum for capturing this species. Data from this site are clearly inflated by this methodological trait, although the species is a common migrant in islands both in the W and C Mediterranean (pers. obs. Cramp, 1985; Spina & Volponi, 2008). In spite of this, the Bee-eater does show some tendency to concentrate at the narrowest crossings of the Mediterranean (Cramp, 1998).

Phenology

The first individuals pass through the study area in early April, giving way to a peak in late April-early May (fig. 3). Numbers during the second half of May are somewhat inflated due to the presence of local birds in Catalonia, but passage is known to occur well into June (Finlayson, 1992; Thévenot et al., 2003). The overall pattern is similar to that reported in S France and the C Mediterranean (Blondel & Isenmann, 1981; Finlayson, 1992; Rubolini et al., 2004). Passage in Morocco occurs somewhat earlier than reported here, beginning in mid-March in the SE and late March in the N (Thévenot et al., 2003). No consistent differences in median dates of passage according to age or sex are observed (fig. 3) as occurs in Italy (Rubolini et al., 2004).

Biometry and physical conditions

Mean values of wing length vary from 147.7 in N Morocco to 149.1 on Els Columbrets (table 1; only one male in wet Balearics 158.5). The mean ranges of wing length by sex are 143.3-147.1 for females and 149.5-151.2 for males, with the lowest means in N Morocco and the highest in the dry Balearics in both cases. The third primary length tends to increase over time, but not significantly (fig. 6).

Overall, birds have low fat reserves, with mean values ranging between 0.6 on Els Columbrets and 1.1 in the dry Balearics, while mean body mass varies from 46.2 on Els Columbrets to 55.8 in N Morocco (table 1). No clear temporal trends are observed in fat, body mass and physical condition (figs. 7-9). Body mass and physical condition are significantly higher in the dry Balearics and Catalonia than on Els Columbrets (also when considering each sex separately).

Our data shows no clear pattern of mass gain in NW Africa or of any difference in condition between continental Spain and the island sites (mass in Catalonia being higher than on Els Columbrets but lower than in the dry Balearics). The few birds ringed in N Morocco have the highest mean body mass, but the differences from Catalonia and the dry Balearics are not significant. Data from S Morocco are also rather inconclusive, since reported mean body mass in the area differs markedly: 48.7 at Defilia (n = 46; Ash, 1969) and 57.6 at Merzouga (n = 20; Gargallo et al., unpubl.) probably due to interannual differences. It thus remains unclear as to whether birds regain some mass while in N Africa.

Stopover

The number of available recaptures is very low (fig. 5), reflecting the low capture rate of this aerial feeder and also a high turnover of birds. A similar lack of retraps has been reported during spring migration in Israel (Yosef et al., 2006). Minimum stopover length and fuel deposition rates based on such a small sample are of little interest.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	131	147.9 ± 4.1 (139.0-159.0)	109.0 ± 4.9 (97.0-119.0)	54.2 ± 4.7 (35.0-66.4)	0.7 ± 0.7 (0-2)
Columbrets	22	149.1 ± 3.8 (144.0-156.0)	110.4 ± 3.1 (105.5-117.5)	46.2 ± 4.0 (40.3-55.0)	0.6 ± 0.4 (0-2)
Balearics (dry)	495	149.0 ± 4.3 (136.0-159.0)	109.5 ± 3.5 (98.0-120.0)	55.6 ± 5.0 (35.7-66.6)	1.1 ± 0.5 (0-4)
Balearics (wet)	1	158.5	115.5	51.1	1.0
Chafarinas	0				
N Morocco	8	147.7 ± 3.9 (140.0-155.0)	107.8 ± 4.6 (99.0-114.0)	55.8 ± 3.2 (49.5-60.5)	0.4 ± 0.5 (0-2)
S Morocco	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	0.04 ± 0.84 (2)		1.61 ± 1.70 (6)			
Retraps >1 day	0.04 ± 0.84 (2)					

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

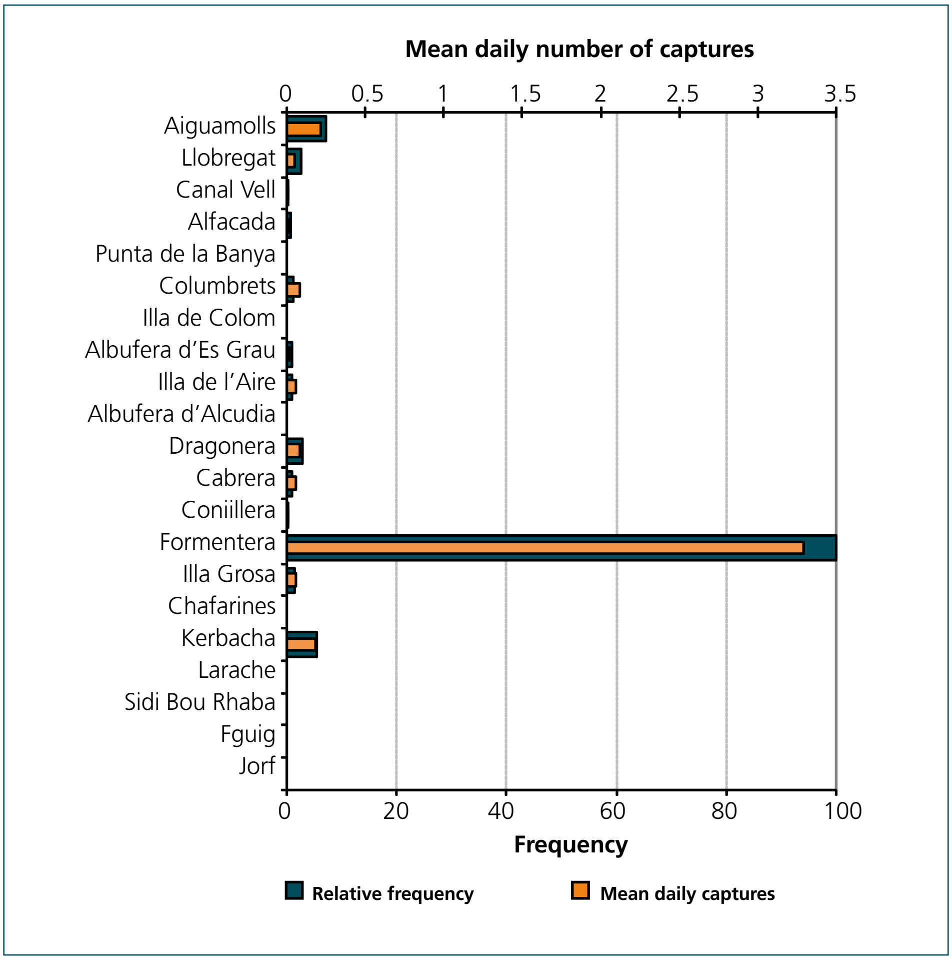


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

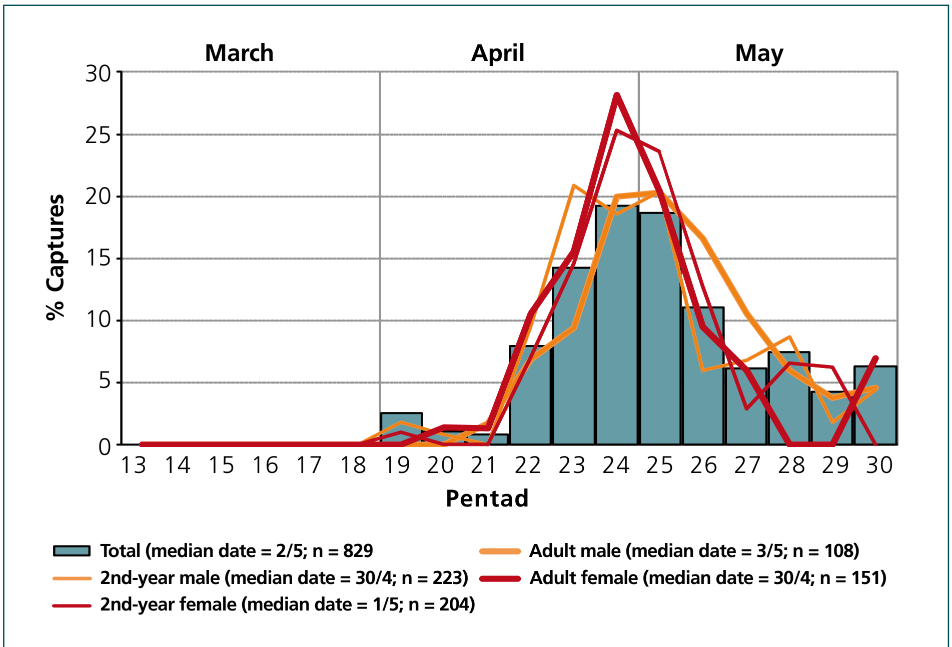


Figure 3. Frequency of captures during the study period.

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

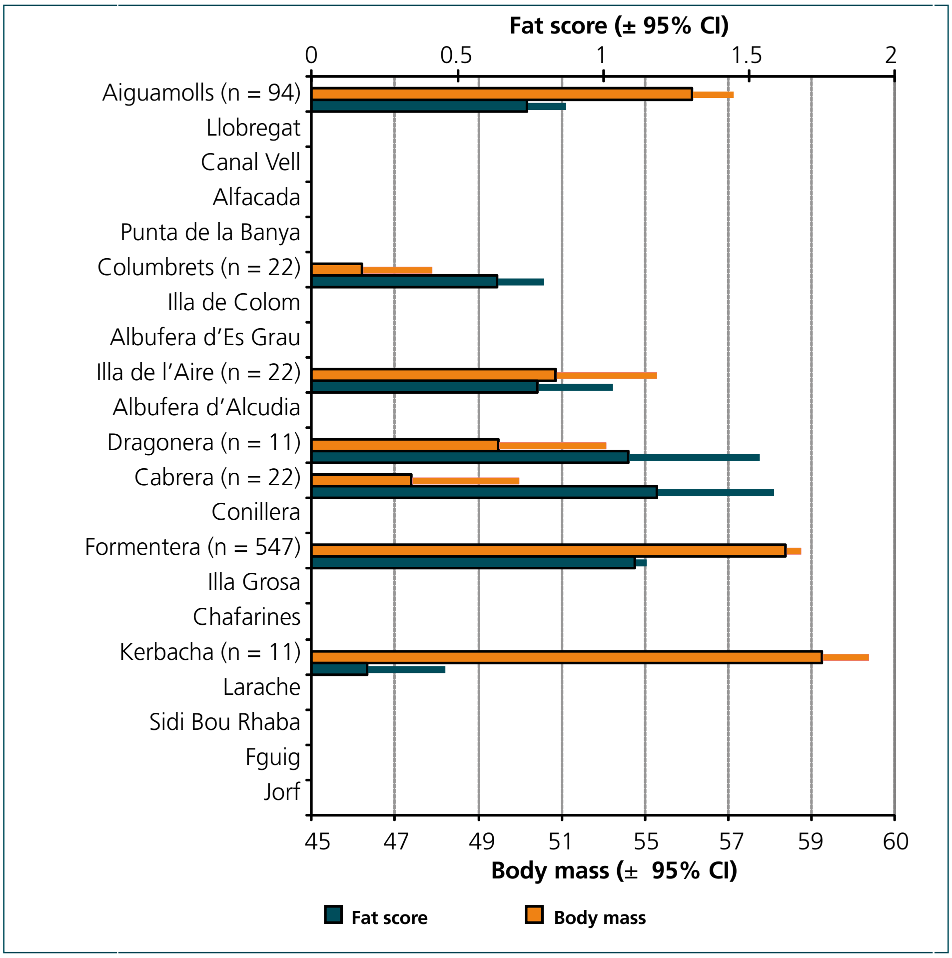
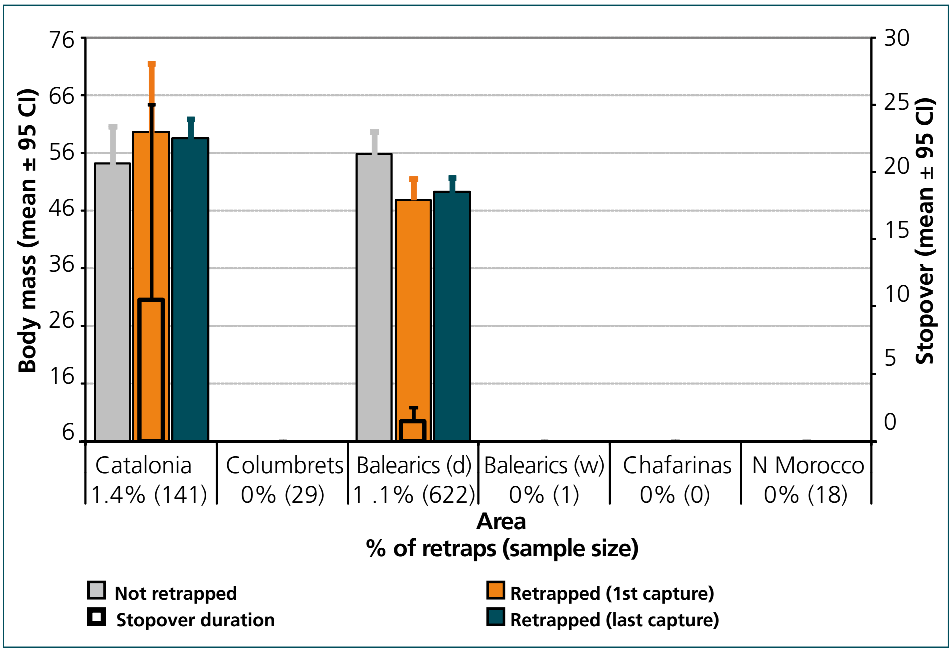


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



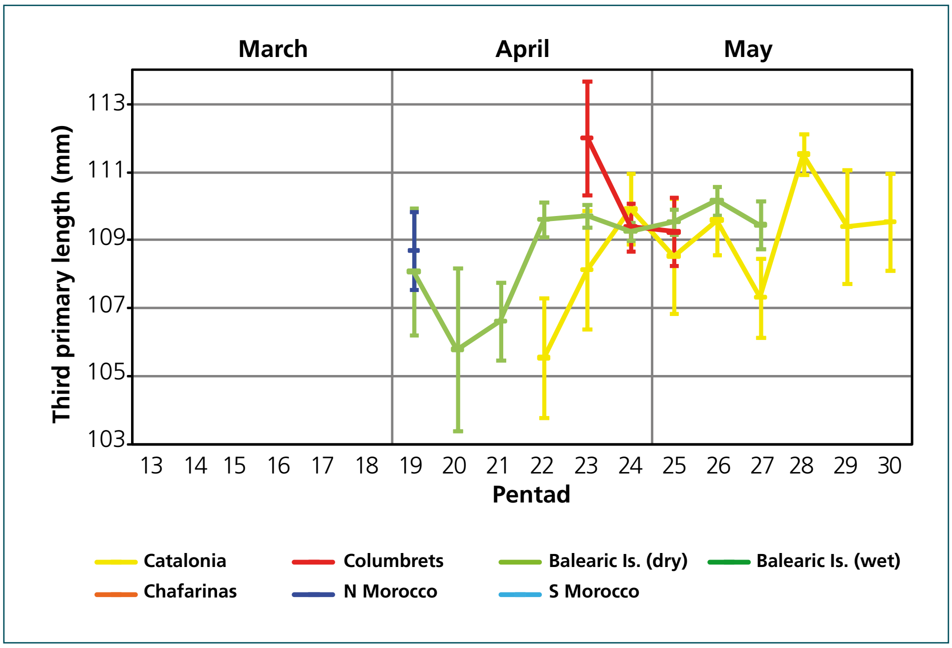


Figure 6. Temporal variation of third primary length according to area.

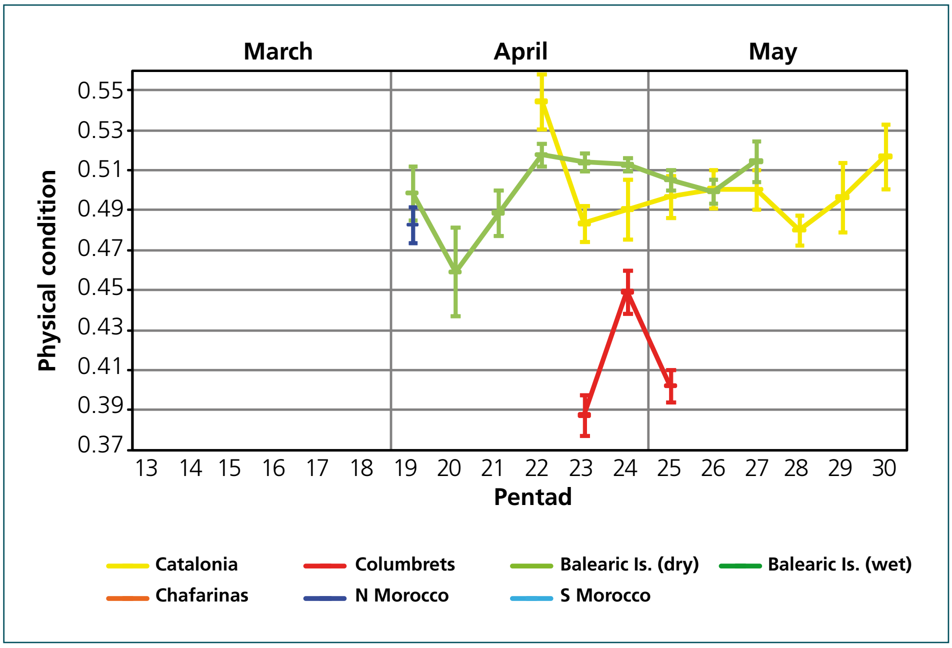


Figure 7. Temporal variation of physical condition according to area.

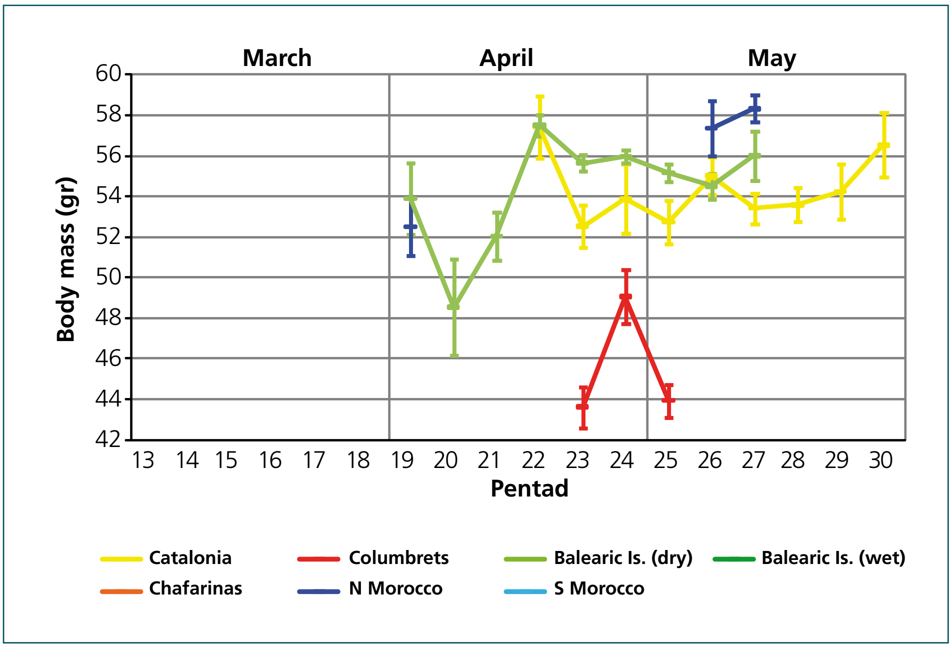


Figure 8. Temporal variation in body mass according to area.

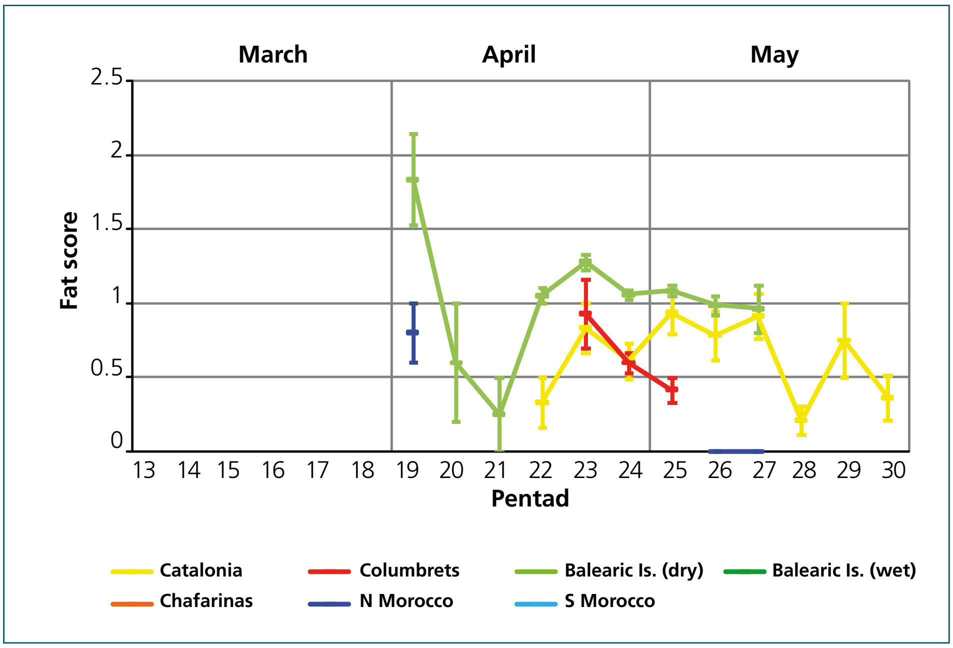


Figure 9. Temporal variation in fat score according to area.

Hoopoe
Upupa epops

Carles Barriocanal & David Robson

Range

The Hoopoe breeds in upper middle to lower latitudes of the W Palearctic (Cramp, 1998). Beyond the W Palearctic, the species is widely distributed in C and S Asia, in Arabia and Madagascar. Small numbers winter in N Africa and the Mediterranean basin, but the European breeding populations winters mostly south of the Sahara (Hagemeijer & Blair, 1997). The Hoopoe breeds in low numbers at some study sites in Catalonia, Morocco and the larger islands of the Balearics, but the vast majority of captures refer to migrants.

Migratory route

The five recoveries available show a predominance of SW-NE movements (fig. 1). One further recovery (not depicted) involves a bird ringed in SE Morocco in April and recovered in Slovakia the following 2 June, 300 km to the NE (Thévenot et al., 2003). The species, therefore, seems to follow a similar axis of movement to that observed in autumn, although in the opposite direction (Cramp, 1985). Some recoveries involve birds migrating across the Mediterranean Sea. In fact, captures are highest, both in relative frequency and in mean daily number, on islands from the dry Balearics where the species does not breed (*e.g.* L'Illa de l'Aire and Cabrera; fig. 2). Although these figures are, perhaps, somewhat overestimated due to a certain attraction effect, they agree with other published data suggesting that the species migrates on a broad front across the Mediterranean (Cramp, 1998). Very few birds are trapped at Moroccan sites, where it is uncommon during migration (Thévenot et al., 2003).

Phenology

Passage starts in early March, peaks between the end of this month and early April and then decreases progressively until mid-May; birds trapped in the second half of May apparently include a significant number of local birds (fig. 3). No differences in the median date of passage is observed between adults and second-year birds. Overall the pattern of passage is similar to that observed in S France (Blondel & Isenmann, 1981) and C Italy (Spina et al., 1993; Rubolini et al., 2004; Spina & Volpini, 2008). In S Iberia migration starts earlier than suggested by present data, being already apparent in February and peaking in March (Finlayson, 1992; Telleria et al., 1999). In Morocco passage is also more advanced and starts in early January in the south and by mid-January in the north, although the main passage period takes place from mid-February to March (Thévenot et al., 2003).

Biometry and physical condition

Mean third primary length ranges from 110.9 in the Balearics to 111.8 on Els Columbrets; mean wing length ranges from 144.6 in the dry Balearics to 145.9 on Els Columbrets (even lower values recorded in the very small dataset from S Morocco; table 1). Mean wing lengths are lower than those reported from islands of the C Mediterranean (mean 147.2, n = 246; Spina et al., 1993) and at Eilat in the E Mediterranean (mean 147.4, n = 56; Morgan & Shirihai, 1997). The third primary does not show any significant temporal trend, probably because, despite the dimorphism in sexual size, protandry is very limited or non-existent and populations of NW Africa and Europe are rather uniform in size (Cramp, 1985; Rubolini et al., 2004).

Mean fat scores range between 0 and 1 and mean body mass varies between 61.4 on Els Columbrets to 67.4 in the wet Balearics (table 1). Fat does not show any appreciable geographic variation, although body mass is distinctly higher in Catalonia than in the dry Balearics and lower on Els Columbrets than in the other two areas (table 1, figs. 8-9). In the wet Balearics body mass is similar to Catalonia, but is also distinctly higher than on Els Columbrets. The poor overall state of birds on Els Columbrets is also reflected in their poorer physical condition (fig. 7). No clear overall trends in body mass and physical condition are observed, although fat does decrease significantly, particularly in the dry Balearics, and body mass and physical condition increase in Catalonia (figs. 7-9).

Mean body mass on Els Columbrets/dry Balearics is rather similar to that reported in the Tyrrhenian islands (mean 62.5, n = 247; Spina et al., 1993), but *c.* 5-9% lower than in continental NE Spain, indicating that birds crossing the Mediterranean Sea have higher energetic stress levels, particularly those captured at isolated and distant sites such as Els Columbrets. Reported mean body mass in La Camargue, S France, is rather low (mean March-May 62.9, n = 141; Cramp, 1985) compared with that from Catalonia and suggests a progressive depletion of energetic reserves during northwards movements through continental Europe. The mean body mass of the tiny data-set from S Morocco is higher than that reported at the nearby sites of Defilia (mean 60.3, n = 36; Ash, 1969) and Merzouga (mean 63.3, n = 17; Gargallo et al., unpubl.), although overall they indicate that many birds arrive in the area with rather low reserves. Body mass in S Morocco is on average up to 10% lower than in continental NE Spain, although a lack of data from N Morocco prevents more detailed analysis as to where and to what extent birds regain mass after crossing the Sahara.

Stopover

The percentage of retrapped birds is low to very low (fig. 5, table 2), suggesting a high turnover of birds. At the two areas with available retraps, fuel deposition rates do not show any significant pattern and retrapped birds do not have significantly different initial body mass than those not trapped again. Mean minimum stopover-length is quite short and is probably somewhat inflated due to the presence of some local breeding birds.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	82	145.0 ± 4.9 (130.9-155.0)	111.7 ± 4.1 (102.5-120.0)	67.2 ± 6.2 (51.0-86.0)	0.8 ± 0.8 (0-3)
Columbrets	37	145.9 ± 4.8 (133.0-156.0)	111.8 ± 4.3 (98.0-122.0)	61.4 ± 7.5 (44.5-89.1)	0.4 ± 0.5 (0-2)
Balearics (dry)	378	144.6 ± 4.9 (131.0-156.0)	110.9 ± 4.5 (98.0-123.0)	63.9 ± 7.5 (43.9-90.6)	0.8 ± 0.7 (0-4)
Balearics (wet)	11	145.2 ± 5.2 (138.0-153.0)	110.9 ± 3.9 (104.5-116.0)	67.4 ± 8.1 (53.7-80.4)	0.8 ± 0.7 (0-2)
Chafarinas	0				
N Morocco	0				
S Morocco	3	143.7 ± 5.5 (137.5-148.0)	108.7 ± 3.3 (105.0-111.5)	67.1 ± 6.6 (61.8-74.5)	

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	0.14 ± 1.20 (5)		-0.52 ± 0.79 (44)			
Retraps >1 day	-0.03 ± 0.25 (3)		0.22 ± 0.56 (25)			

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

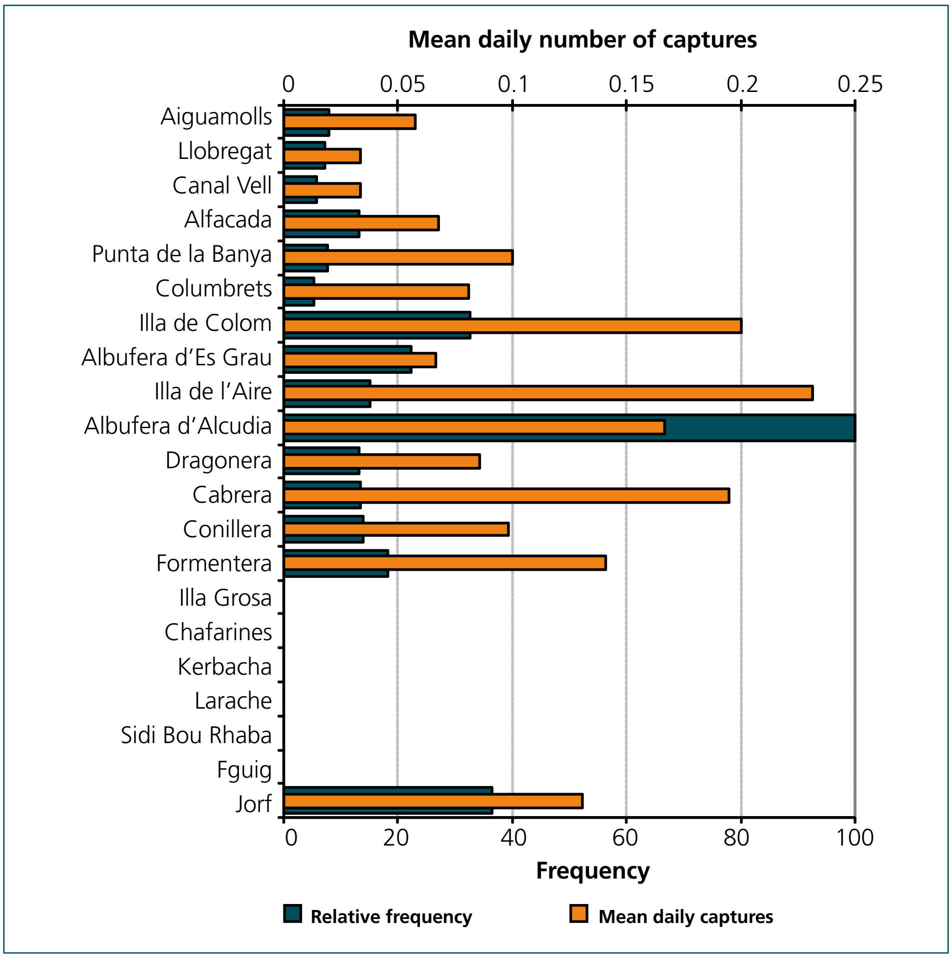


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

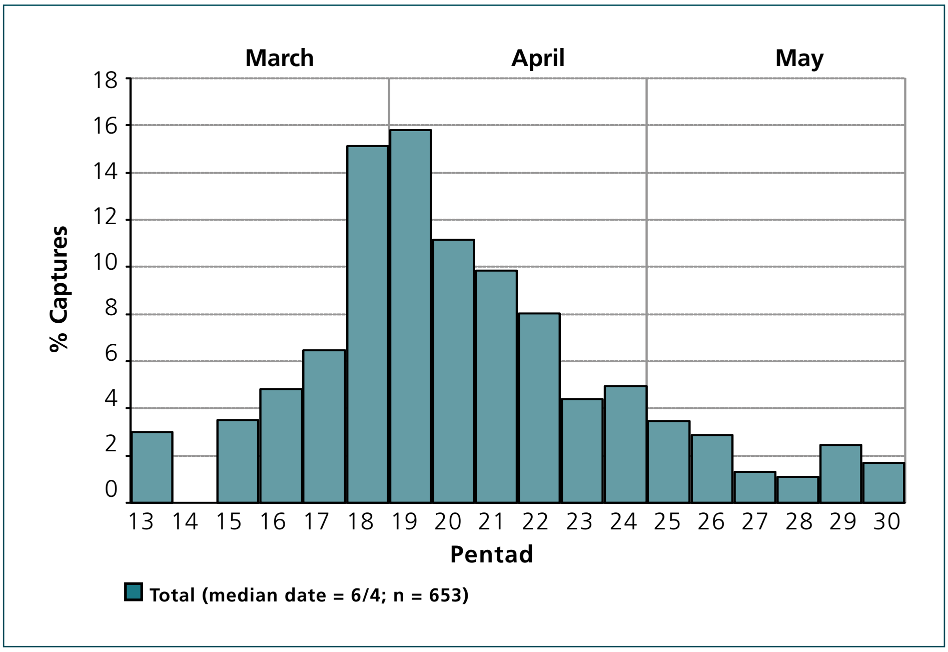


Figure 3. Frequency of captures during the study period.

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

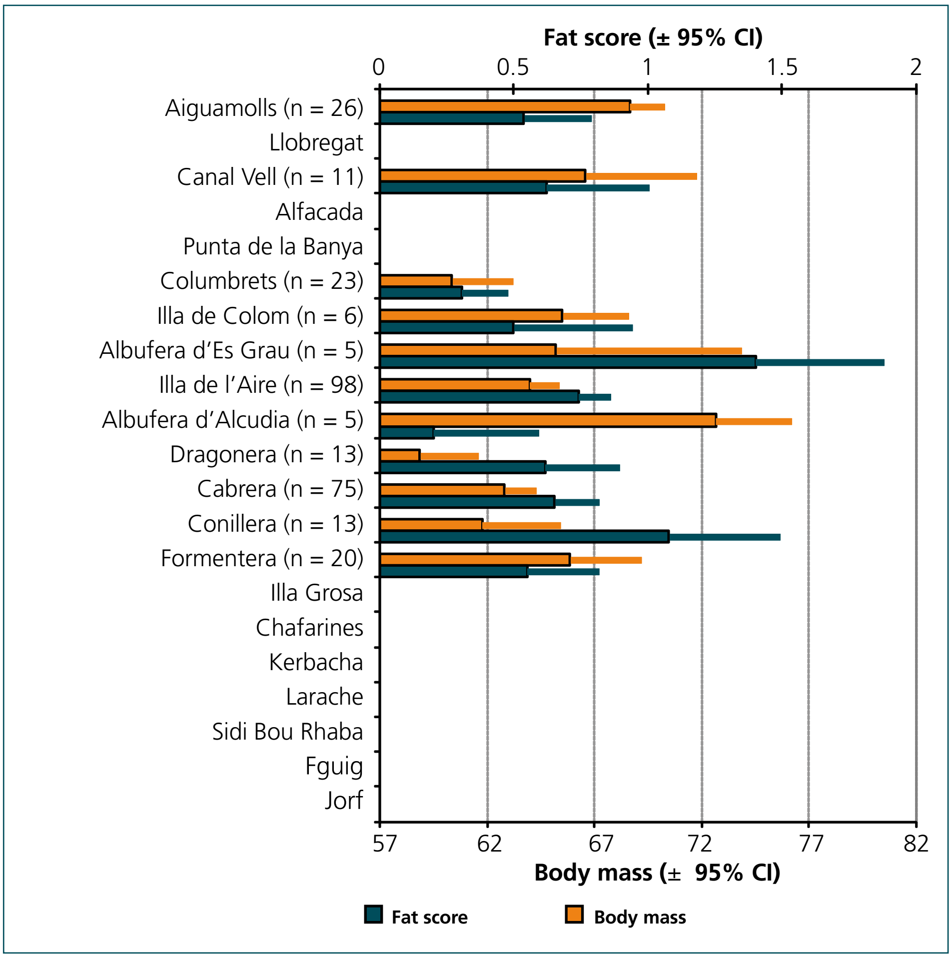
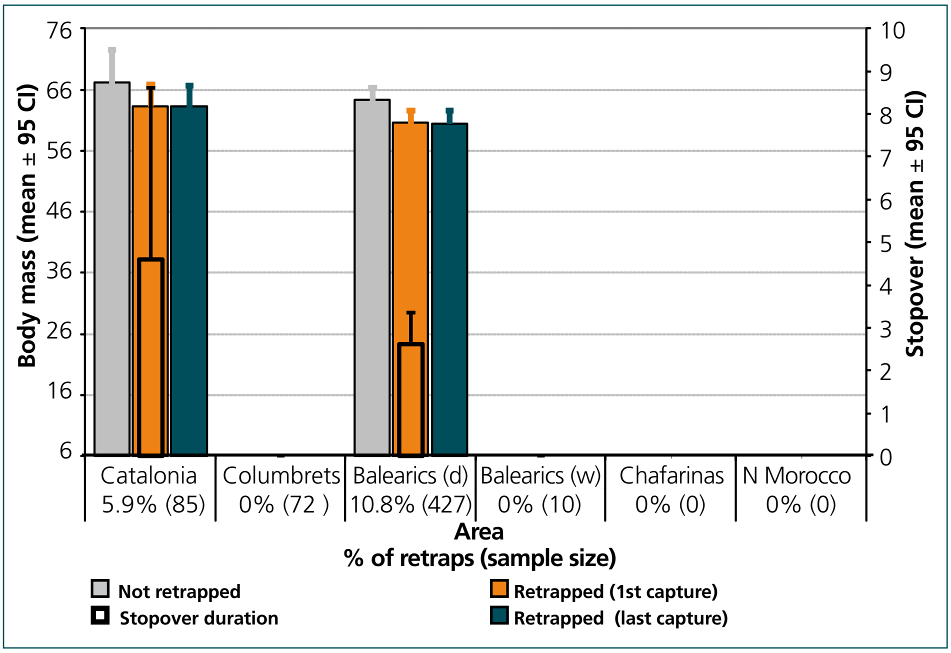


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



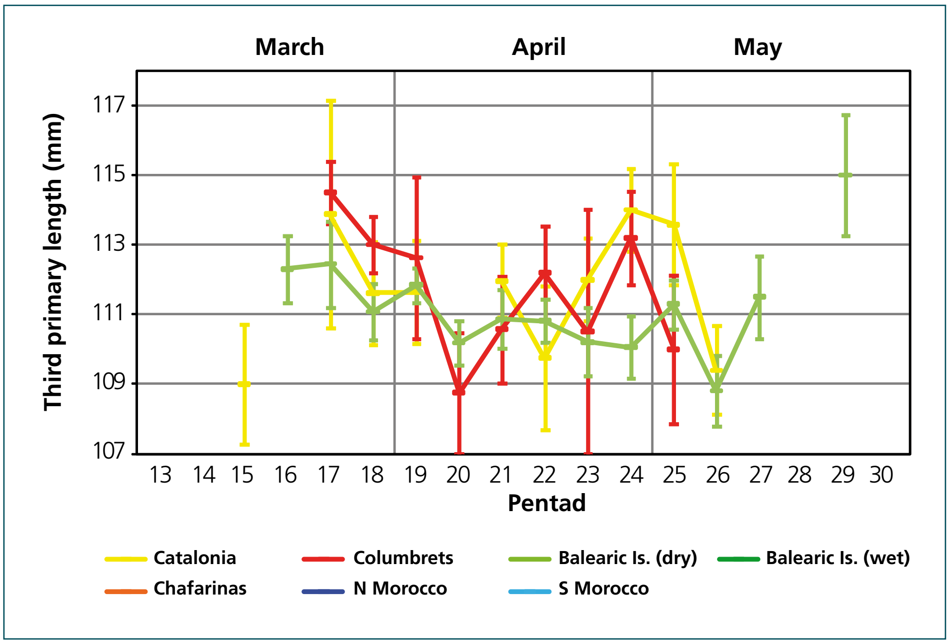


Figure 6. Temporal variation of third primary length according to area.

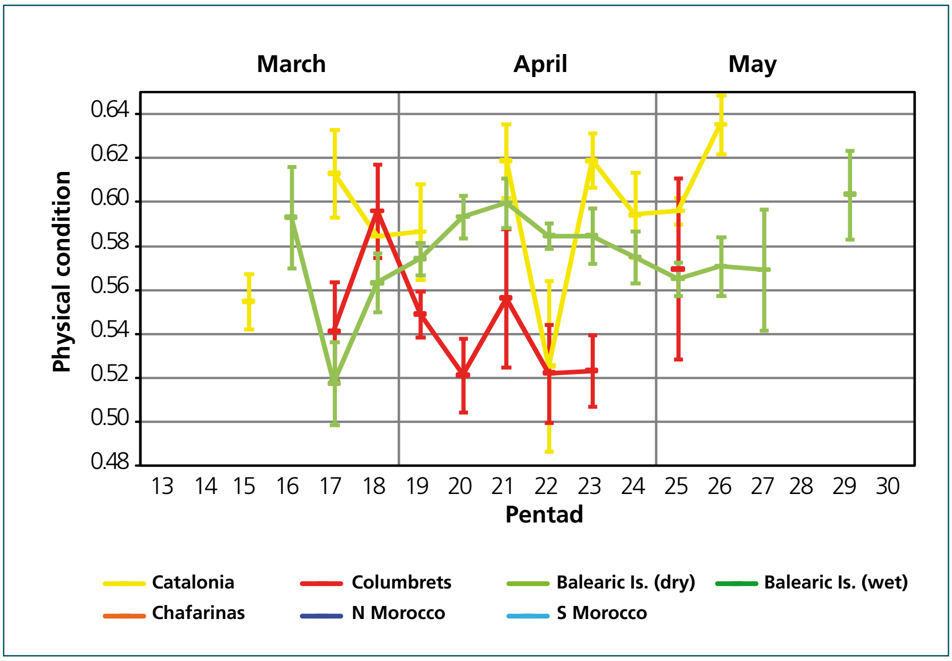


Figure 7. Temporal variation of physical condition according to area.

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

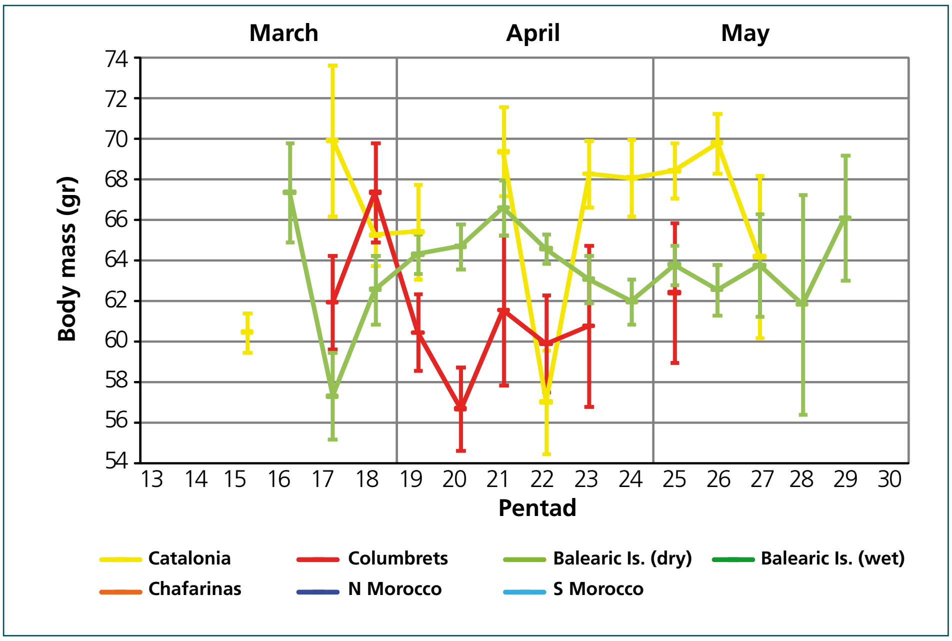
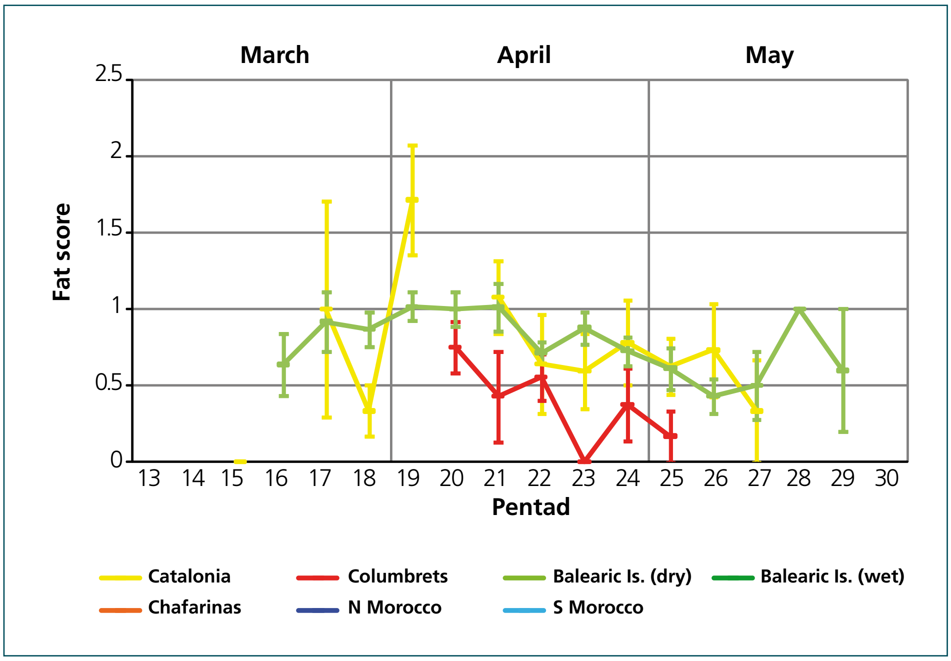


Figure 9. Temporal variation in fat score according to area.



Sand Martin
Riparia riparia

Carles Barriocanal & David Robson

Range

The Sand Martin is a trans-Saharan migrant that is widely distributed throughout the Palearctic and Nearctic (Cramp, 1988, Hagemeijer & Blair, 1997). It breeds in most of Europe and throughout much of Asia south to S Pakistan and C China (Cramp, 1998). Eastern populations winter in E and SE Africa, while W Palearctic populations winter in the Sahel and in E Africa south to Mozambique (Cramp, 1998).

Migratory route

Available recoveries show that movements occur largely along a S-N axis, although some birds move more towards the NE or even E-NE and others move SE-NW towards Britain (fig. 1). This species is thought to migrate in a broad front across the Sahara, as far east as 10°E, but it is not clear if birds arriving on the southern Mediterranean coastline have a preference for migrating over land or across the open sea (Mead, 2002). In spring they are particularly commoner in SE Morocco than on the Atlantic coast or in the Gibraltar area (Thévenot et al., 2003), while recoveries of British birds are more common in eastern NW Africa in spring than in autumn, suggesting some readiness to cross the sea. In autumn, however, birds leaving Britain follow short sea crossings (Cramp, 1988) indicative of a reluctance to fly over large expanses of sea. Although the sample is very small (n = 6), the lack of recoveries of birds from the Balearics/Els Columbrets heading NE or E-NE may also indicate that the main passage takes place west of the islands and along the eastern Iberian coast.

Most captures and the highest frequencies occur in Catalan wetlands, although they are also relatively high at some insular wetlands (*e.g.* L'Albufera d'Alcúdia; fig. 2).

Phenology

Birds are trapped from late March to late May, but mostly between April and mid-May and peaking in the second half of April (fig. 3). These data, however, fail to depict adequately the arrival of the species to the W Mediterranean. In fact, birds reach S Iberia from late February onwards (occasionally in January) and Catalonia by late February and early March (Bernis, 1971; Finlayson, 1992; ICO, 2010). In Morocco the main passage period occurs from early March to mid-May, but migrants are already present in February and even January in the SW (Thévenot et al., 2003). Some birds pass through the study area even in late June (Cramp, 1988; Telleria et al., 1999; Thévenot et al., 2003). The species does not usually arrive in S France until mid-March (Blondel & Isenmann, 1981). The arrival date of Sand Martins in Europe is closely correlated with temperatures, even more so than in the Barn Swallow (Sparks & Tryjanowski, 2007), and therefore fluctuates in relation to the spring weather.

Biometry and physical condition

The average third primary length ranges from 82.6 on Els Columbrets to 83.0 in Catalonia (one bird from N Morocco of 82.0; table 1) without significant differences between sites. Mean values in wing lengths vary from 106.1 (wet Balearics) and 107.2 (dry Balearics) and are within the values reported for the nominate subspecies in Europe (Cramp, 1998) and the E Mediterranean (Morgan & Shirihai, 1997). These values are slightly lower than those from the few birds trapped in spring migration in N Tunisia (mean 108.4, n = 8; Waldenström et al., 2004). No clear temporal trend in third primary length is observed, probably due to a lack of marked sexual size dimorphism and geographical variation in size.

Mean body mass varies from 10.6 on Els Columbrets to 13.4 in Catalonia (and 14.7 in the sole bird from N Morocco), while mean fat scores range from 0.6 to 2.9 at the same sites (again the sole bird from N Morocco had a higher value of 4.0). Body mass, physical condition and fat show an overall trend to increase with time (figs. 7-9), indicating that later birds suffer less energetic stress. Birds captured in Catalonia are heavier and in better physical condition than those in the insular study areas (too little available data from Morocco), while those from Catalonia and the wet Balearics have more fat than on Els Columbrets and in the dry Balearics (table 1, figs. 7-9).

The few captures in S Morocco are of birds that are reasonably heavier than those reported elsewhere in the same region: 11.3 at Defilia (n = 255; Ash, 1969) and 10.8 at Merzouga (n = 11; Gargallo et al., unpubl.). Nevertheless, in all cases figures are 8-19% lower than those obtained close to the Mediterranean coasts of Morocco and Tunisia (mean 13.3, n = 9; present data and Waldenström et al., 2004), where the species is commoner in spring than in autumn (Thévenot et al., 2003; Isenmann et al., 2005). On the other hand, mean body mass in these latter areas and in Catalonia and S England (mean 13.2, n = 50; Ash, 1969) are very similar, suggesting that in NW Africa birds may regain some of the mass lost after crossing the Sahara, but that afterwards migration takes place largely by means of short flight bouts that do not require important gains in mass. As shown by the low mean body masses observed in birds captured on the islands, only those reaching Europe after crossing extensive expanses of sea seem to suffer particularly from energetic stress.

Stopover

No retraps are available, in part due to the species' aerial feeding habits, but probably also because it is not tied to any particular stopover site for refuelling during migration.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	525	107.1 ± 3.3 (98.0-119.0)	83.0 ± 2.4 (77.0-90.0)	13.4 ± 1.3 (9.7-16.8)	2.9 ± 1.3 (0-6)
Columbrets	7	106.5 ± 5.5 (98.0-116.0)	82.6 ± 1.6 (80.5-85.0)	10.6 ± 0.8 (9.6-12.0)	0.6 ± 0.7 (0-2)
Balearics (dry)	56	107.2 ± 3.5 (101.0-117.0)	83.2 ± 2.5 (79.0-90.0)	11.5 ± 1.4 (8.4-15.6)	1.1 ± 1.2 (0-6)
Balearics (wet)	14	106.1 ± 1.9 (103.0-109.5)	82.4 ± 1.6 (79.0-85.0)	12.2 ± 1.2 (10.6-15.0)	2.4 ± 1.5 (0-5)
Chafarinas	0				
N Morocco	1	107.0	82.0	14.7	4.0
S Morocco	3	106.7 ± 2.9 (105.0-110.0)	83.7 ± 2.6 (81.5-86.5)	12.2 ± 0.4 (11.9-12.6)	1.7 ± 0.6 (1-2)

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						
Retraps > 1 day						

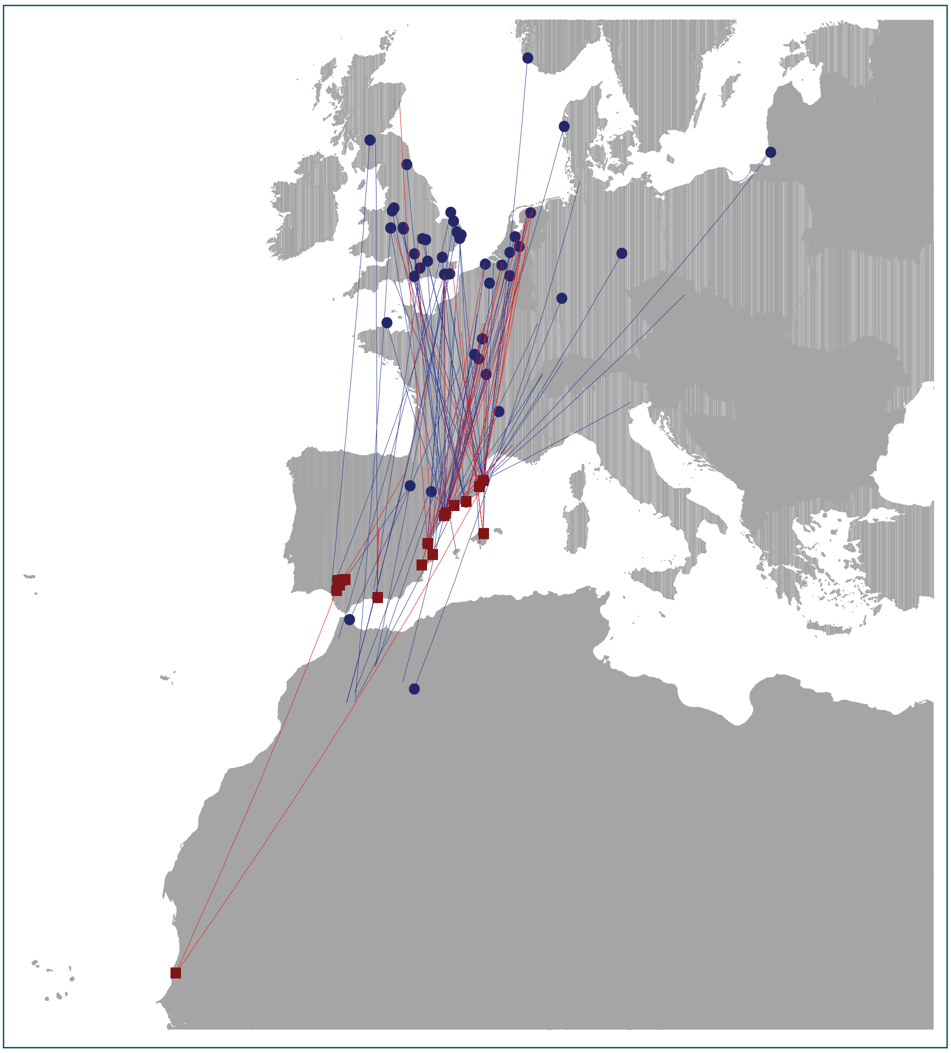


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

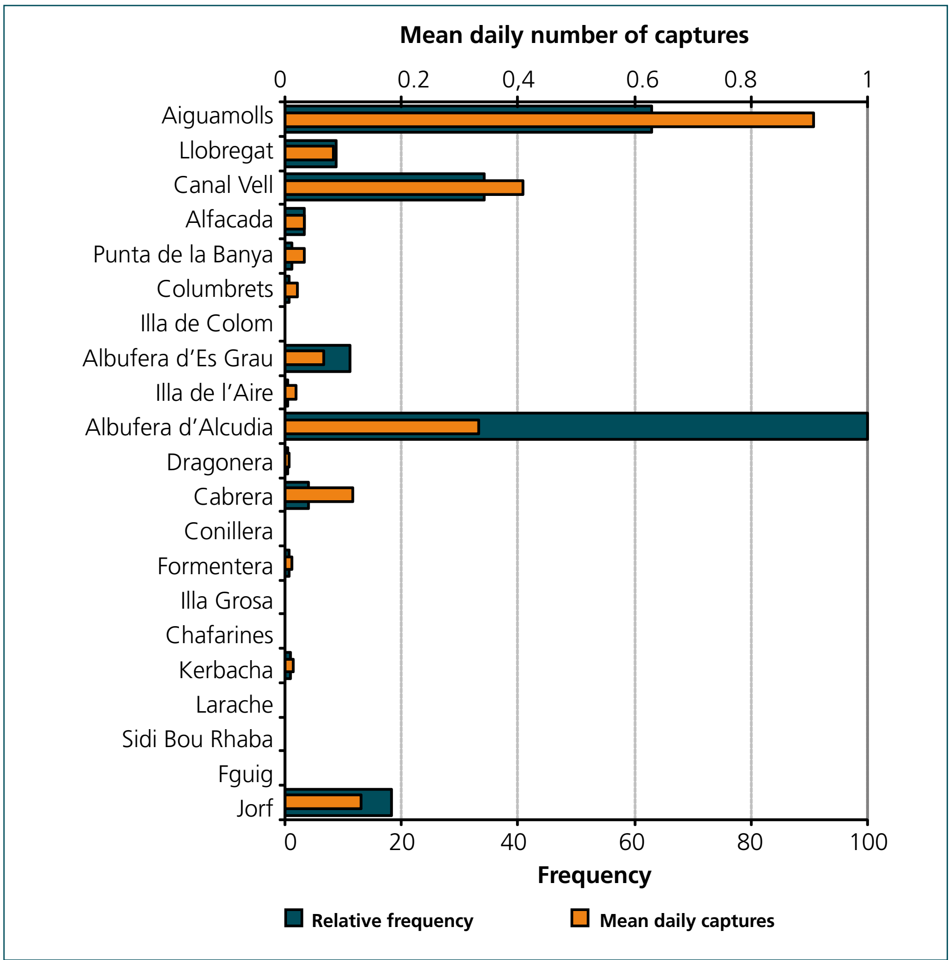


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

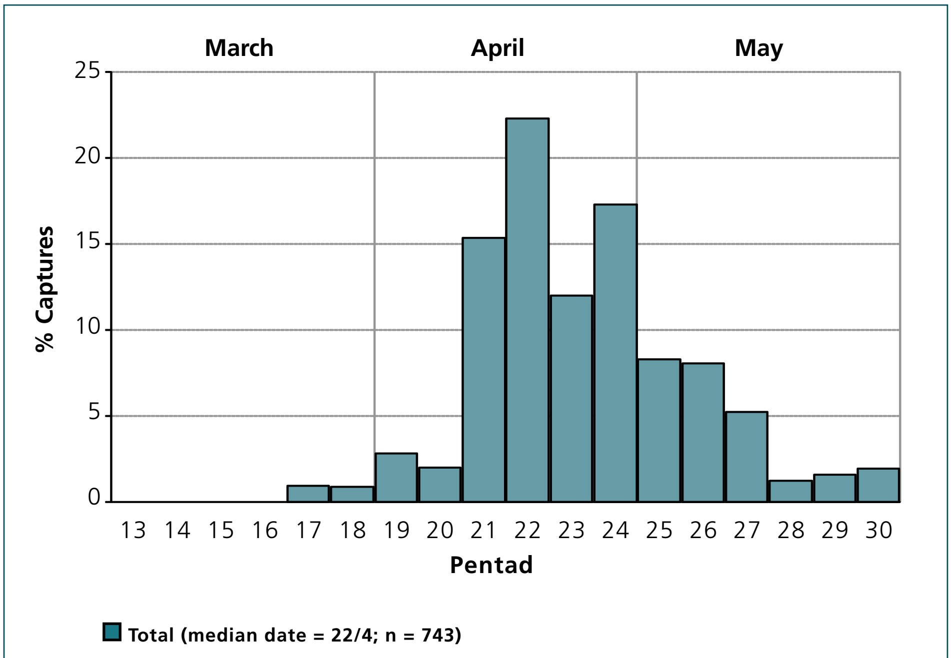


Figure 3. Frequency of captures during the study period.

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

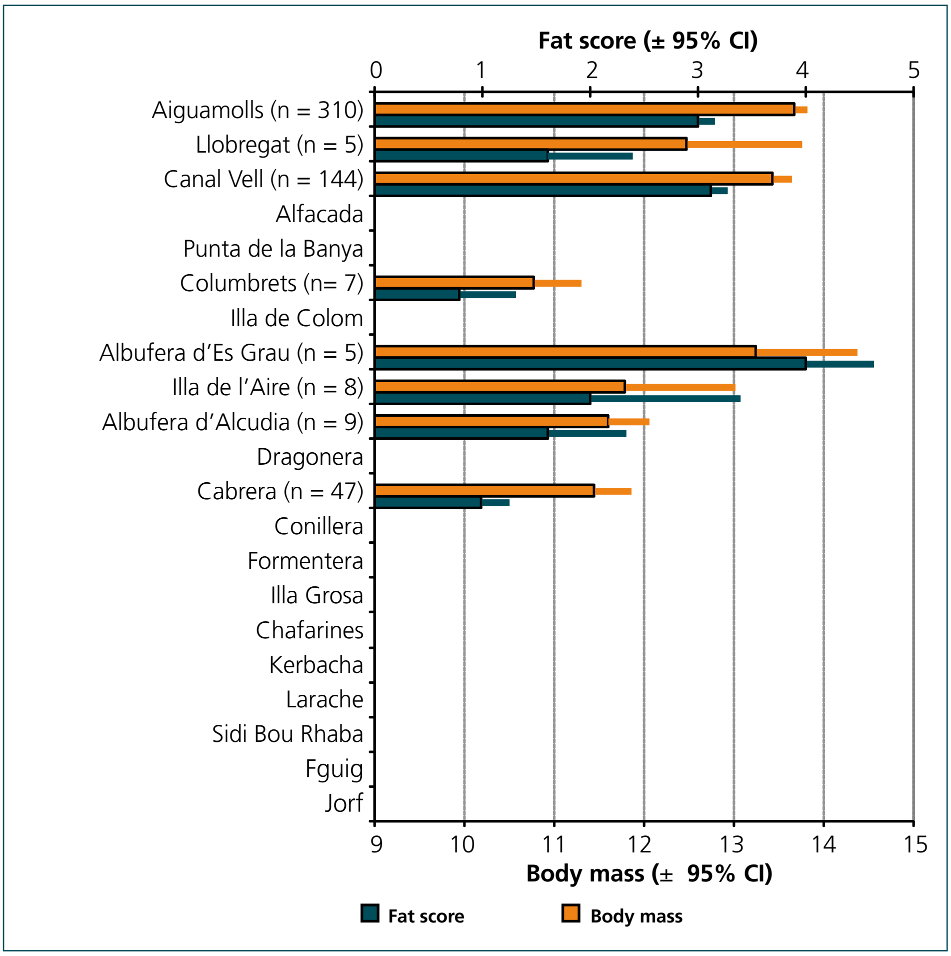
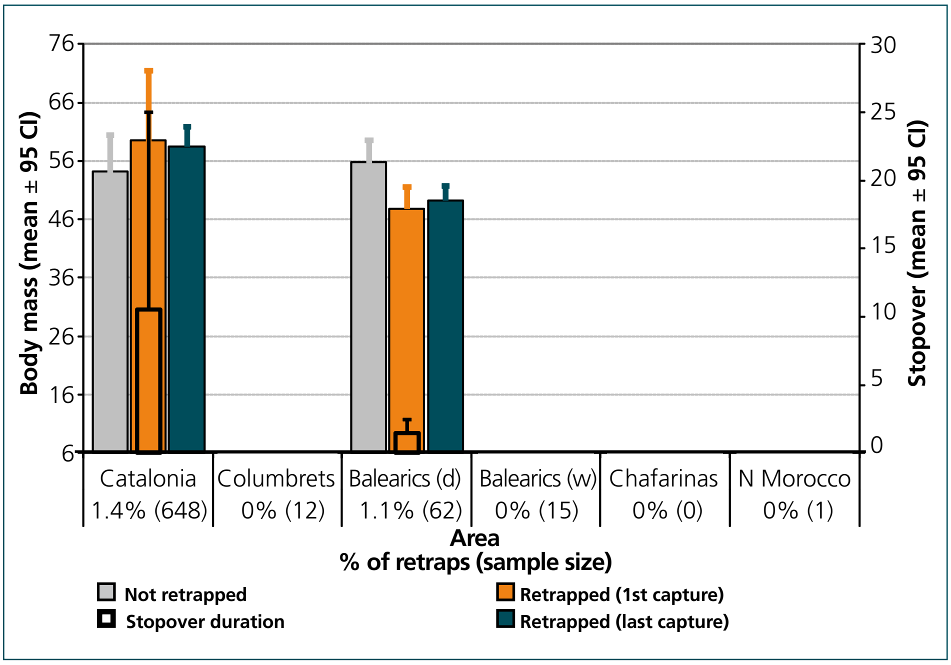


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



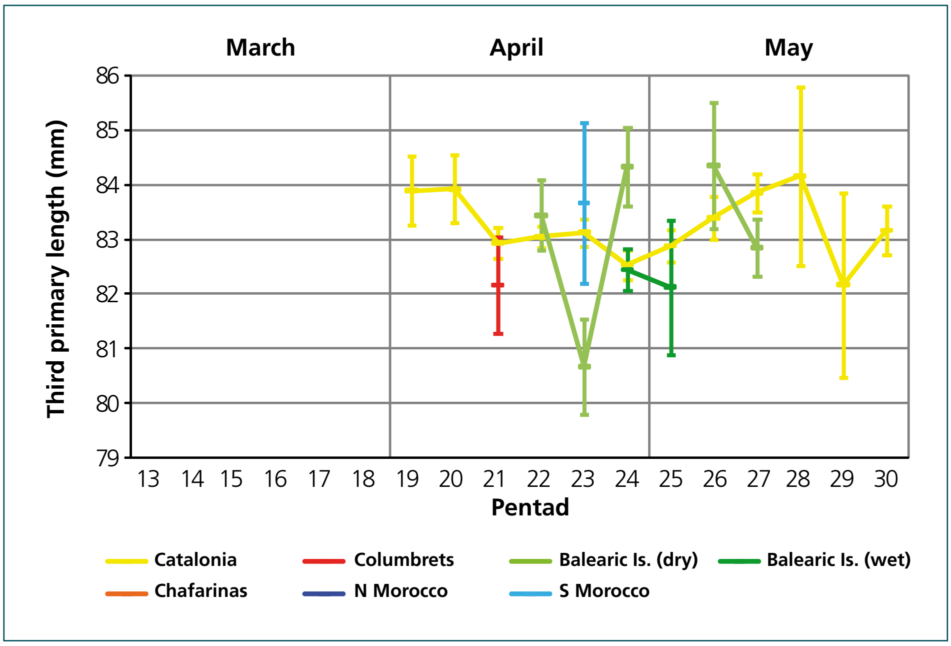


Figure 6. Temporal variation of third primary length according to area.

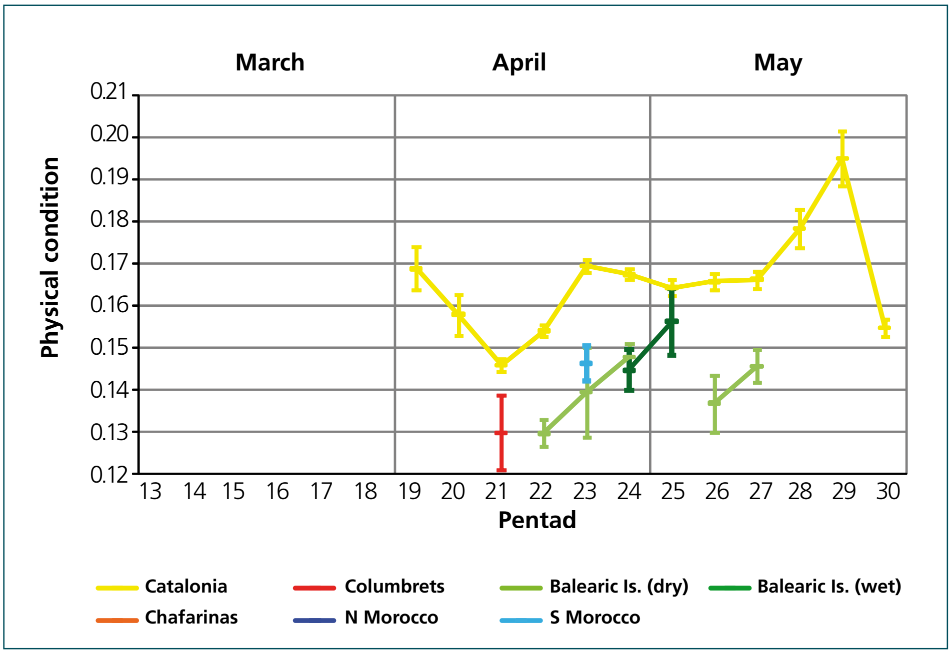


Figure 7. Temporal variation of physical condition according to area.

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

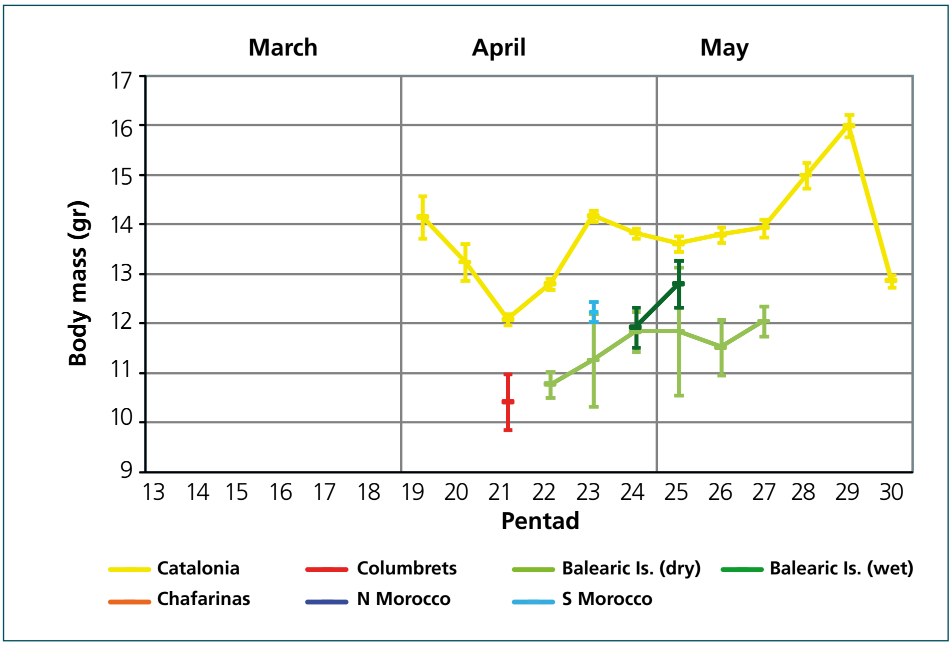
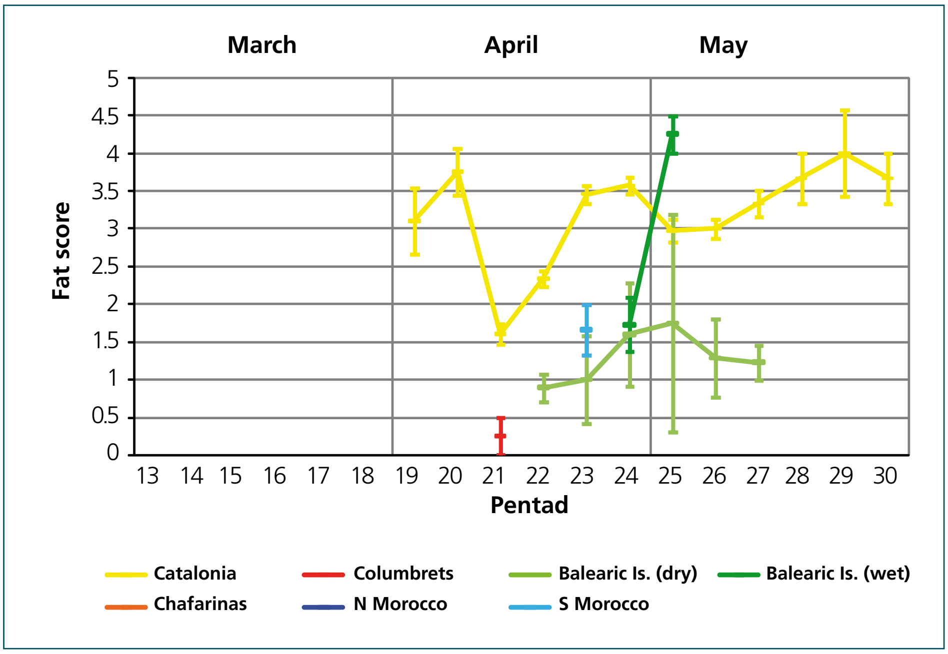


Figure 9. Temporal variation in fat score according to area.



Barn Swallow
Hirundo rustica

Carles Barriocanal & David Robson

Range

The Barn Swallow breeds throughout most of the Palearctic and the winter quarters of C and S European Swallows are presumed to be in W and C Africa (Van den Brink et al., 1998; Moller et al., 2003; Saino et al., 2004; Gordo et al., 2007). Swallows from N and NW Europe appear to migrate further S, with recoveries from South Africa, Botswana and Namibia, while birds from E Europe and the Baltic tend to winter in the eastern part of C and S Africa; some birds winter regularly in S Spain (Cramp, 1988; Telleria et al., 1999). It breeds throughout the study area except on the small islands. However, even where it breeds the vast majority of birds trapped are migrants.

Migratory route

Ringing recoveries show that the main migration route follows a SW-NE axis of movement, although good numbers also move in a more E or N to N-NW direction (fig. 1). The overall pattern reveals the importance of the E coast of the Iberian Peninsula for migratory birds, and some direct recoveries have been made between Gibraltar and NE Spain. The high frequency of N to N-NW movements suggests the birds use a more eastern route in spring than in autumn, as observed in Italy and N Africa (Cramp, 1988; Spina & Volponi, 2008). There is also some passage across the sea (Balearic Islands), and the birds captured on the most western islands tend to move in a more N-NW direction than those from the eastern islands.

Our data supports the view that western populations of Barn Swallow use the western flyway in both autumn and spring (Szep et al., 2006). Gibraltar is apparently the main entry point into Europe for this species (Moreau, 1953; Bernis, 1962). Gordo et al. (2007) have shown that the bulk of birds enter the Iberian Peninsula through its south western corner and then follow the main river basins north-eastwards; just a few birds take a direct route across the sea. The latitudinal increase in body mass throughout sites in mainland Spain (Catalonia; fig. 8) also suggests that most birds arrive after crossing favourable areas. Wetlands have the greatest frequency of captures (fig. 2), probably because they constitute good feeding and roosting areas.

Phenology

Passage occurs from early March onwards, but mostly from April to mid-May (fig. 3). The beginning and the peak of passage in the W Mediterranean seems to occur, however, earlier than suggested by the ringing data presented here. In Spain arrivals begin in February and main passage occurs in March-April in the south and from mid-March to mid-April in the NE (Telleria et al., 1999; ICO, 2010). In Morocco, passage begins from December to mid-January, but mostly March-May (Thévenot et al., 2003). The overall timing in NE Spain rather similar to that reported in the C Mediterranean (Spina et al., 1993; Morgan & Shirihai, 1997). In accordance with published data (Cramp, 1988), males pass some days earlier than females (fig. 3), but in both cases two peaks are observed. This may be related to age groups since second-year birds return later than older birds (Moller & De Lope, 1999). The passage of two distinct populations (see below) might also play a part since recoveries show that birds of northern origin tend to pass later.

This species shows strong phenotypic responses to short-term changes in weather patterns during migration (Robson & Barriocanal, 2008) and arrival dates are strongly correlated to climatic fluctuations and environmental conditions in their passage and wintering areas. Thus, arrival dates vary between years and have been related to variables such as spring temperatures in Europe (Huin & Sparks, 1998; Sparks et al., 2001), precipitation levels in the Sahel (Gordo et al., 2005) and the density of plant growth in winter and passage areas (Moller, 2004; Saino et al., 2004; Gordo & Sanz, 2008).

Biometry and physical condition

Average third primary length ranges between 93.9 in S Morocco to 96.3 in the wet Balearics (table 1). Average wing length ranges from 122.1 to 123.8 in the same sites, within the range of values found in N Africa and N Europe (Cramp, 1988). Third primary lengths tend to decrease with time, particularly in Catalonia and the dry Balearics, which would seen to reflect the differential passage of sexes mentioned above, with larger males (Cramp, 1988) passing earlier.

The mean values for fat scores lie between 0.6 on Els Columbrets and 3.7 in N Morocco; the mean body mass varies from 15.6 to 20.2 at the same sites. Fat, body mass and the condition index increase significantly during the season in most areas except on Els Columbrets, where the opposite is observed (figs. 7-9). Body mass, fat and physical condition are greatest in N Morocco and intermediate in Catalonia and the wet Balearics, and have the lowest averages in the dry Balearics and, above all, on Els Columbrets (figs. 7-9). Body mass in the dry Balearics is similar to that reported from the Tyrrhenian islands (16.7, n = 426; Spina et al., 1993). Figures from S Morocco are remarkably high. Available data on body mass from nearby sites but in different years, however, show much lower values: mean 16.0 at Defilia (n = 2,357; Ash, 1969) and 16.2 in Merzouga (n = 86; Gargallo et al., unpubl.). This important difference probably reflects year- or habitat-specific differences that require further research. Indeed the mean mass for Defilia in 1966 was 19.0 (n = 126), *c.* 25% higher than in the other years for which data is available (1963-1965; Moreau, 1969).

Overall, mean body mass in N Morocco is *c.* 6-20% higher than in the south of the country, indicating that this area plays an important role as a refuelling site for birds that have crossed the Sahara. Body mass in SW Spain (*e.g.* mean at Illa Grossa 18.0, n = 21) and Catalonia are *c.* 10% lower than in N Morocco. The lower figures for the dry Balearics and on Els Columbrets show that the energetic demands on birds crossing over the sea are higher, although data from the wet Balearics indicate that at insular sites with more suitable feeding areas birds are in similar condition to in continental Spain.

Stopover

The lack of recaptures may be indicative of high turnover or methodological drawbacks that reflect the difficulty in recapturing aerial foragers. Barn Swallows are diurnal migrants that forage on the wing and are therefore less tied to a particular stopover site (Turner, 2006). The few retrapped birds tend to lose mass (significantly so in the dry Balearics when considering all retraps) and have lower mass than those not retrapped (again only significantly so in the dry Balearics). Sample sizes are too small, however, to allow for a more conclusive analysis.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	5,563	123.6 ± 3.1 (110.0-135.0)	95.8 ± 2.7 (85.0-104.5)	18.5 ± 1.8 (10.4-25.0)	2.4 ± 1.3 (0-6)
Columbrets	333	123.6 ± 3.4 (112.0-134.0)	95.6 ± 2.8 (85.5-104.0)	15.6 ± 1.6 (10.1-21.4)	0.6 ± 0.8 (0-4)
Balearics (dry)	1,557	123.4 ± 3.3 (112.0-133.5)	95.7 ± 2.9 (85.5-104.0)	17.1 ± 1.9 (10.3-24.4)	1.7 ± 1.2 (0-7)
Balearics (wet)	312	123.8 ± 3.4 (112.5-134.0)	96.3 ± 2.8 (89.0-104.0)	18.5 ± 1.8 (13.9-23.4)	2.3 ± 1.0 (0-6)
Chafarinas	9		95.1 ± 1.6 (92.5-97.0)	17.2 ± 1.7 (13.9-19.2)	1.4 ± 1.4 (0-4)
N Morocco	108	122.7 ± 3.2 (113.0-130.0)	95.1 ± 2.5 (89.0-102.0)	20.2 ± 2.3 (15.5-24.7)	3.7 ± 1.6 (0-6)
S Morocco	203	122.1 ± 3.5 (113.0-130.0)	93.9 ± 2.6 (88.0-100.0)	19.0 ± 1.9 (13.5-23.5)	2.5 ± 1.0 (1-5)

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	-0.71 ± 0.90 (14)	-1.15 ± 0.31 (5)	-0.42 ± 0.26 (19)			
Retraps >1 day	-0.08 ± 0.46 (8)		-0.33 ± 0.42 (6)			

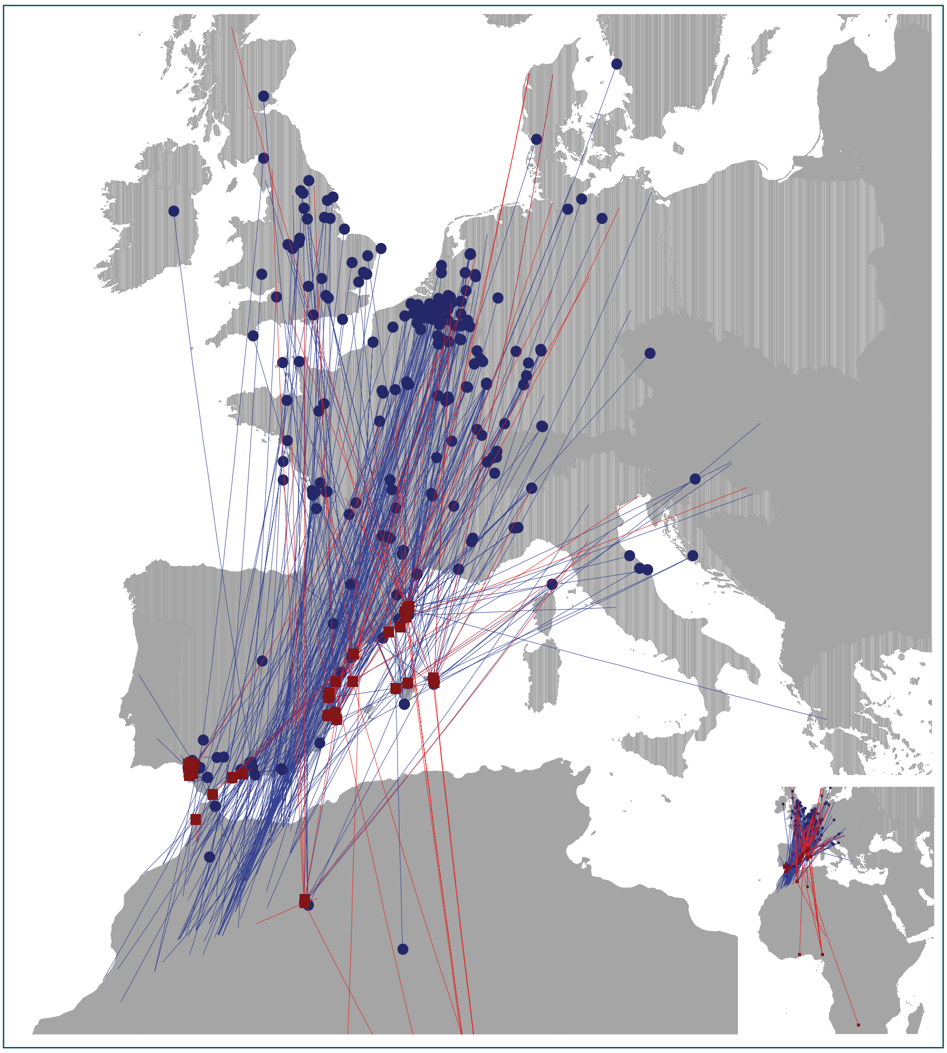


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

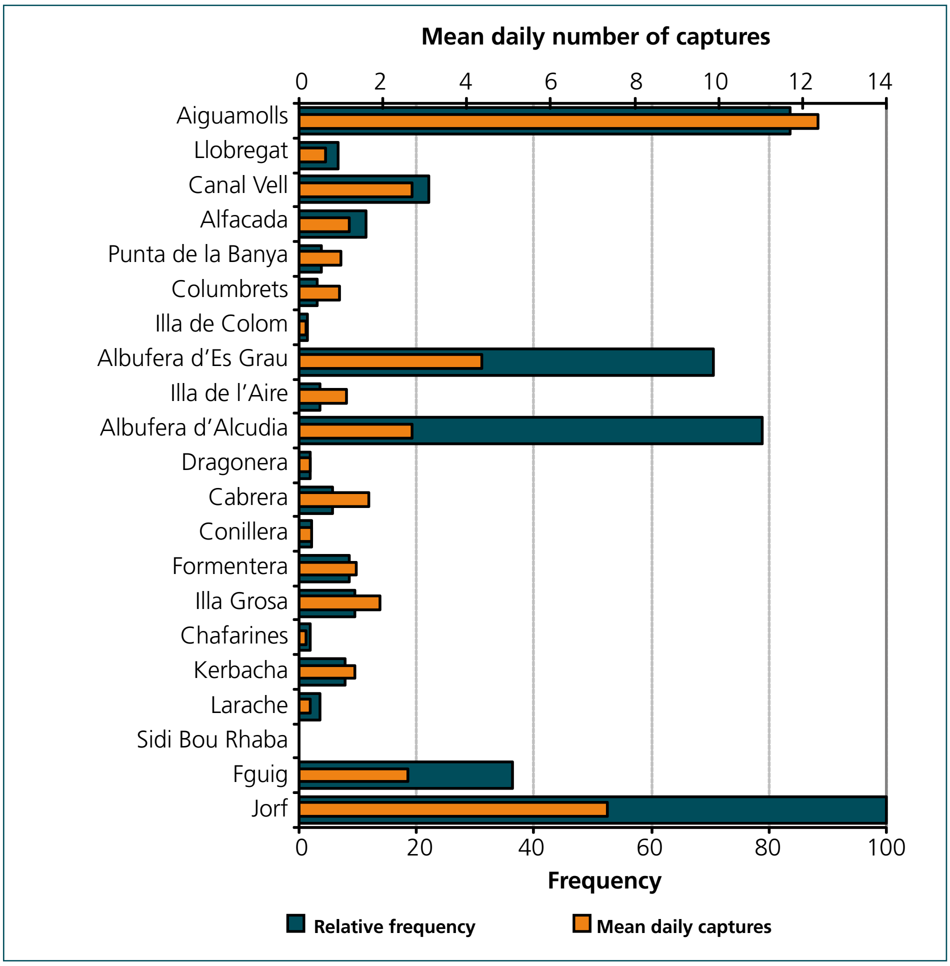


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

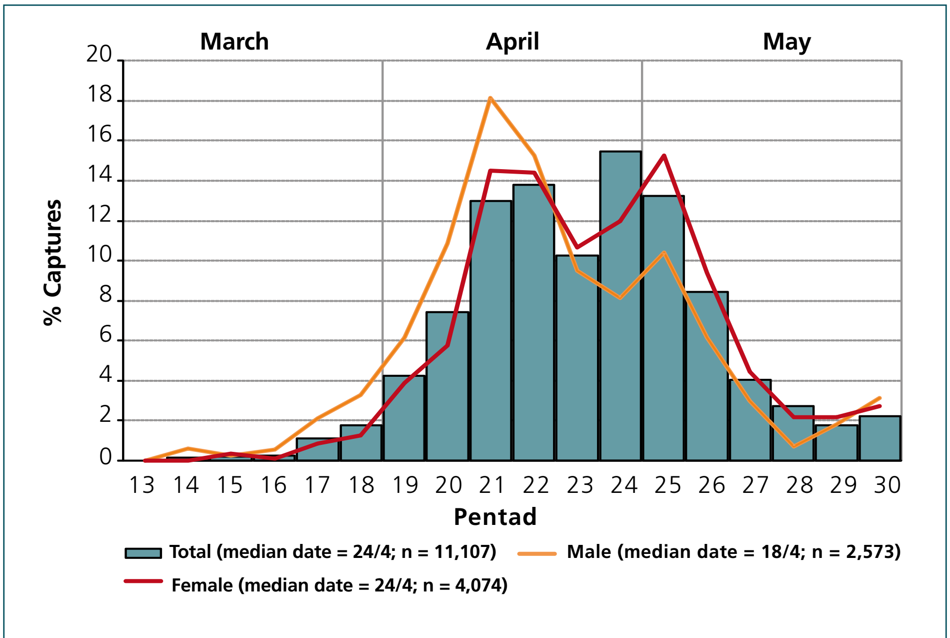


Figure 3. Frequency of captures during the study period.

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

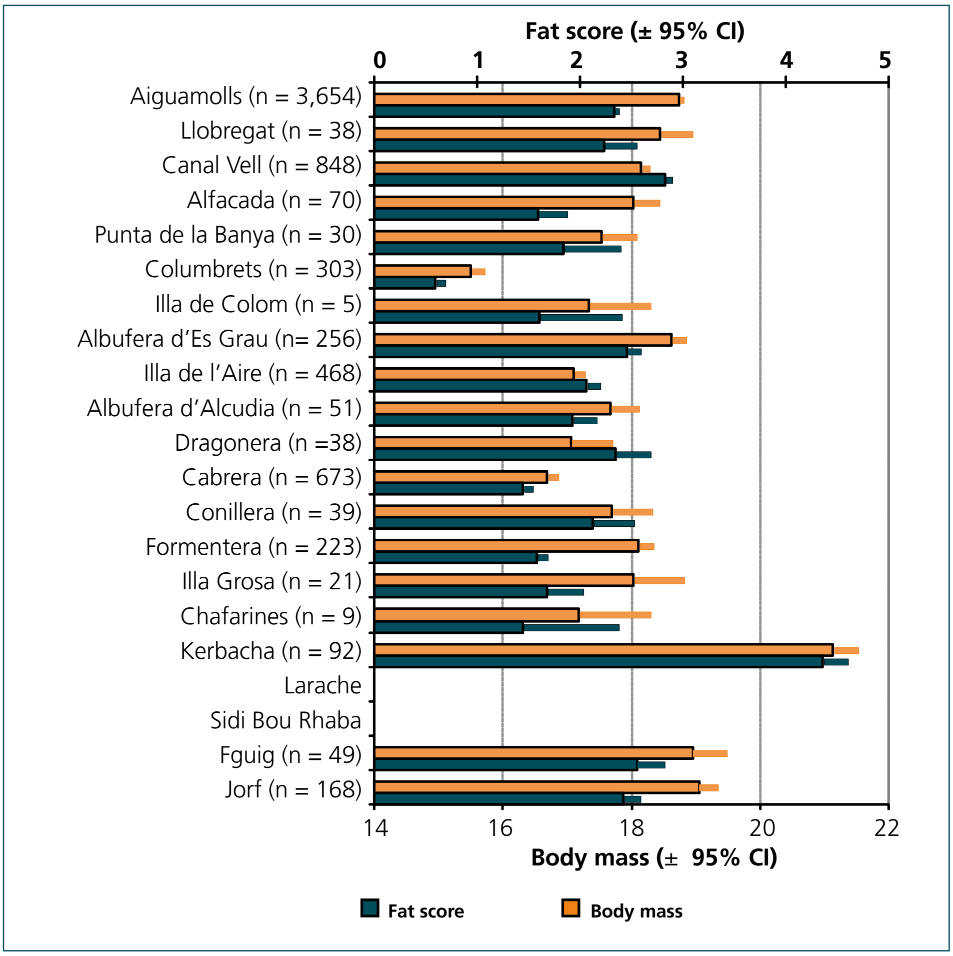
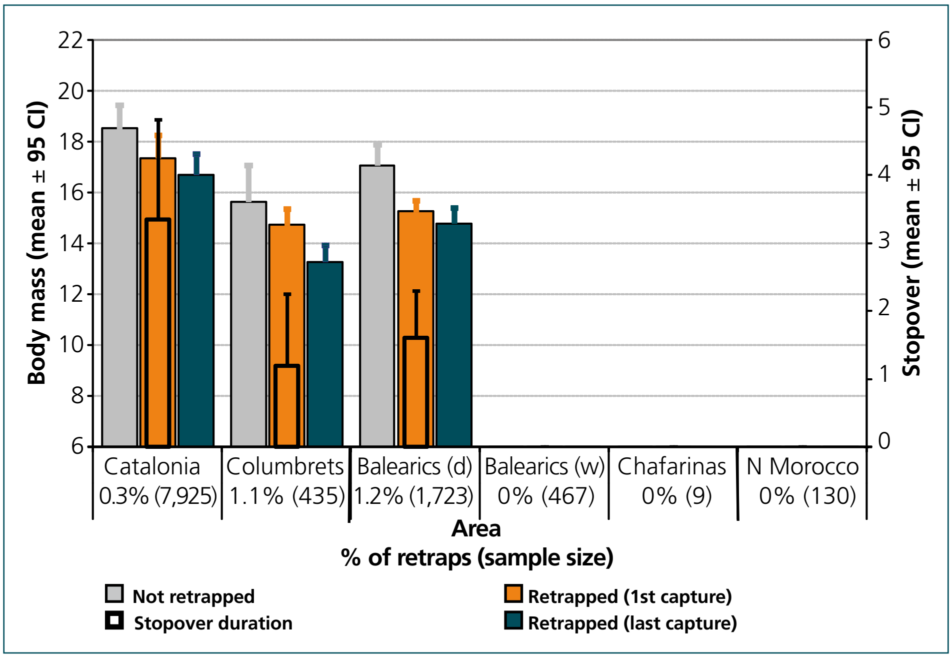


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



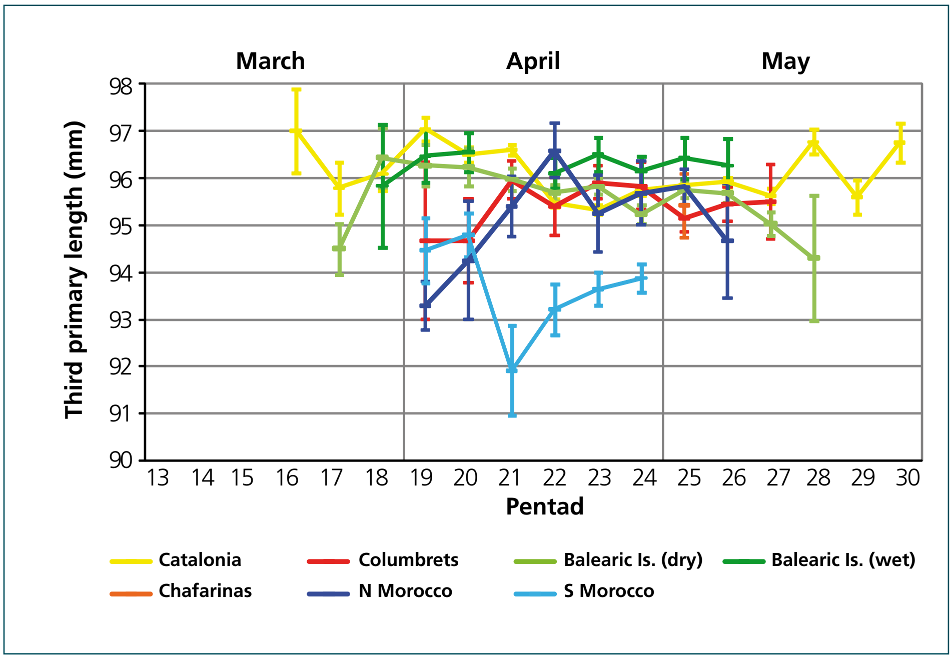


Figure 6. Temporal variation of third primary length according to area.

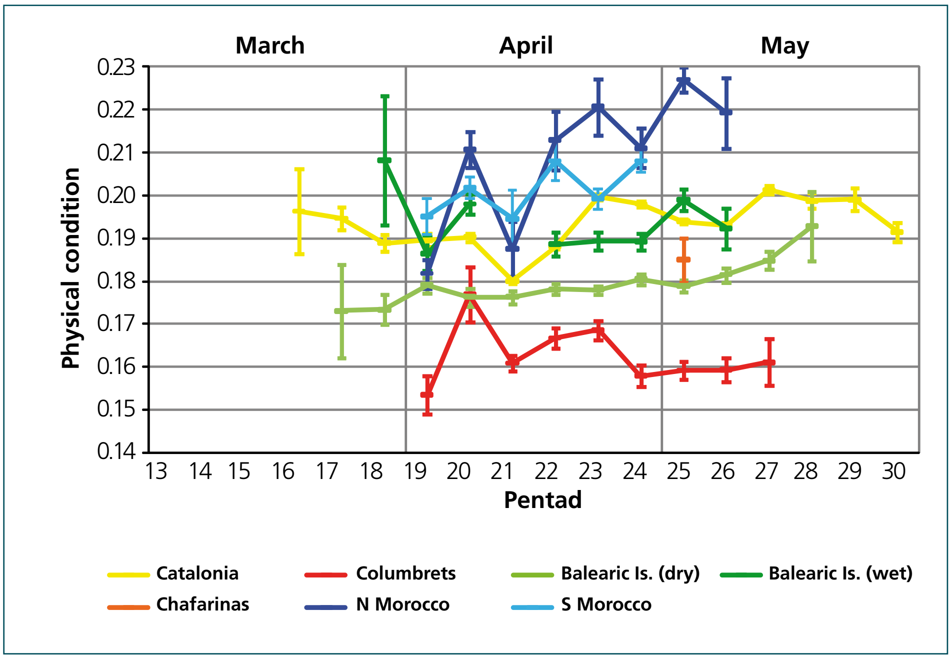


Figure 7. Temporal variation of physical condition according to area.

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

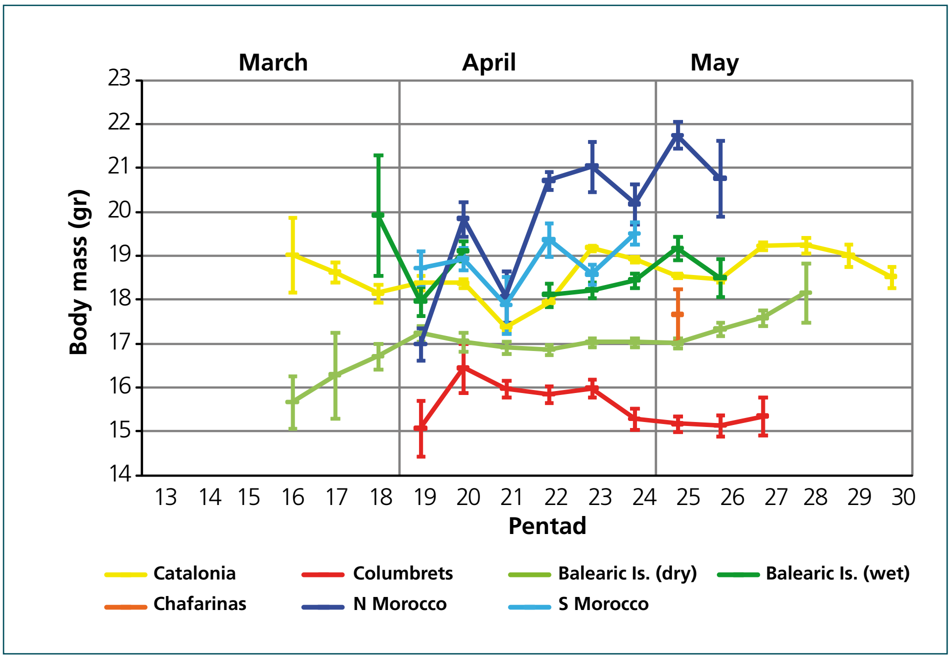
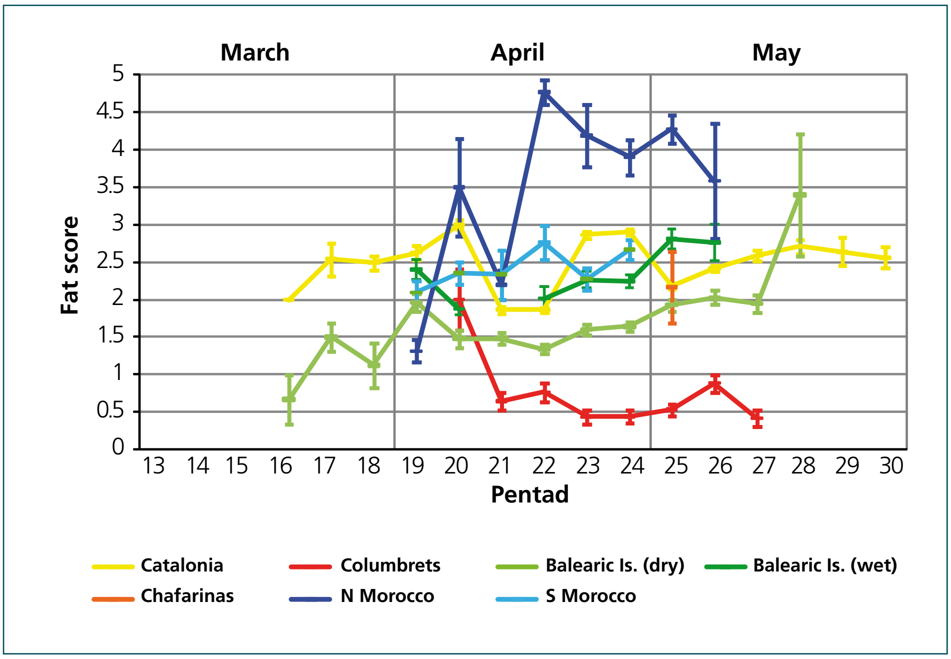


Figure 9. Temporal variation in fat score according to area.



House Martin

Delichon urbicum

Carles Barriocanal & David Robson

Range

The House Martin is a polytypic species that inhabits almost the entire Palearctic. There are five subspecies, although the nominate race is the only one that breeds in Europe (Hagemeijer & Blair, 1997). Beyond the W Palearctic, it is widely distributed in C and N Asia, south to Iran, Himalayas, and S China (Cramp, 1998). It is a long-distance migrant, European populations wintering in the Afrotropics (Cramp, 1998). It is a common breeding species in Spain and N Morocco, but does not breed at the specific sites where the ringing campaigns are conducted.

Migratory route

The available recoveries show a prevalence of SW-NE movements in the W Mediterranean (fig. 1). The species migrates in broad front, with birds passing through the study area belonging to populations from SW Europe and the British Islands, but those passing further to the E tending to originate from more E and N Europe (Wernham et al., 2002). One bird ringed in early April in SE Morocco and recovered two years later in Tunisia, also in early April, (Thévenot et al., 2003), indicates that some individuals cross the Mediterranean by very different sites in different years. On the other hand, spring recoveries from UK birds show a front of passage spanning from E Spain to Italy (Hill, 2002; Wernham et al., 2002), indicating that birds of similar origin can cross the Mediterranean by different migratory routes.

Unlike the other two hirundines discussed here (Barn Swallow and Sand Martin), this species attains some of the highest relative and absolute number of captures on some islands (fig. 2), reflecting the passage of many birds across the Mediterranean Sea. The species is more frequent in E Morocco than on the Atlantic coast during migration (Thévenot et al., 2003).

Phenology

Captures span from mid-March to late May and peak in April (fig. 1), although the sample size is quite limited and the pattern of passage seems to fail to depict with precision the phenology of the species in the W Mediterranean. In S Iberia and Catalonia, migration generally peaks in April, but arrival takes place from February onwards (Finlayson, 1992; Telleria et al., 1999; ICO, 2010); in Morocco migration is very protracted, peaking between mid-March and mid-May, with the first arrivals seen from early January onwards (Thévenot et al., 2003). The passage across the Tyrrhenian islands peaks between mid-April and mid-May (Petersson et al., 1990; Spina et al., 1993), apparently somewhat later than in the W Mediterranean.

Biometry and physical condition

This species presents a strong latitudinal cline in size, with mean values of wing length increasing by about 1 mm each 2.2 degrees of latitude N (Cramp, 1998). The distinct differences in size had led to the proposal of three races within Europe: *urbica* in N Europe with wing length 115-123, *fenestratum* in Central Europe and British Islands with wing mainly 107-115, and *meridionalis* in S Europe with wing 100-107 (Clancey, 1950). Although these races are not generally accepted (see Vaurie, 1959), these size differences are fairly appreciable and can help determine the origin of birds passing in migration.

Mean values of wing length vary from 106.0 (N Morocco) to 108.3 (Els Columbrets). Mean third primary lengths range from 82.0 (Catalonia) to 86.3 (N Morocco), without significant differences between regions (table 1). In general, mean figures are somewhat lower than in the C Mediterranean (mean 84.1, n = 134; Spina et al., 1993), reflecting the passage of a lower proportion of birds of more northern origin in comparison with areas further to the E (see above). Third primary length tends to increase with time, but only significantly so in the wet Balearics (fig. 6). A similar trend is observed in the C Mediterranean (Spina et al., 1993) and in both cases is apparently caused by the later migration of more northern, longer- winged birds, a common pattern in polytypic migrants (Blondel, 1967).

Mean fat scores range between 0.3 (Els Columbrets) and 2.4 (wet Balearics), and body mass from 13.8 (Els Columbrets) to 16.8 (wet Balearics; table 1). Fat shows no clear overall temporal tendency, since no trend is detected in most areas, while it decreases significantly in the wet Balearics and increases in Catalonia (fig. 9). Body mass and physical condition increase significantly with time, particularly in the two areas with most available data (*i.e.* Catalonia and dry Balearics; figs. 7-8). In Catalonia and wet Balearics fat, body mass and physical condition are higher than in the dry Balearics and, particularly so, on Els Columbrets, where birds attain the lowest means (table 1). Overall, mean body mass in the Balearics/Els Columbrets is similar to that reported on islands in the C Mediterranean (mean 14.8, n = 134; Spina et al., 1993).

The mean body mass of birds trapped in S Morocco is similar to that reported at the nearby sites of Defilia (mean 14.5, n = 252; Ash, 1969) and Merzouga (mean 15.0; n = 15; Gargallo et al., unpubl.). The very scarce data available from N Morocco show a similar average to S Morocco, although the mean mass reported from a similarly tiny sample from N Tunisia is much higher (mean 19.6, n = 3; Waldenström et al., 2004).

The fact that birds trapped on insular sites located in wetlands are distinctly heavier than on the other islands suggests that these habitats provide much better opportunities for stopover and refuelling (*cf.* Ktitorov et al., 2008). However, birds from dry islands show average masses similar or even below those reported in S Morocco, a clear indication that they are under greater energetic stress. Birds migrating through continental Europe may gain mass en route, since the average in Catalonia is rather low compared with that reported in May from sites in Britain and the Netherlands (mean 18.4, n = 15; Cramp, 1988).

Stopover

The few retraps available are all from the dry Balearics (table 2, fig. 5). The initial mass of retrapped birds is much lower than that of those not trapped again and their fuel deposition rates do not differ from zero. These results suggest that only birds in particularly poor condition stay some days in these areas. The low percentage of birds recaptured is probably due among other reasons to the en route feeding habits of the species (Cramp, 1988), which is not necessarily tied to any particular stopover site.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	127	107. 8 ± 3.4 (99.5-117.0)	82.0 ± 2.5 (75.5-88.5)	15.9 ± 1.4 (11.8-19.2)	1.3 ± 1.1 (0-4)
Columbrets	44	108.3 ± 3.7 (98.0-117.0)	82.7 ± 2.9 (78.0-89.5)	13.8 ± 1.4 (11.1-17.3)	0.3 ± 0.5 (0-2)
Balearics (dry)	192	107.6 ± 3.9 (97.5-117.0)	82.1 ± 3.1 (75.0-91.0)	14.8 ± 1.7 (10.6-21.0)	1.0 ± 1.0 (0-5)
Balearics (wet)	24	107.0 ± 2.7 (101.0-112.0)	83.0 ± 3.5 (75.5-92.0)	16.8 ± 1.8 (13.0-21.7)	2.4 ± 1.2 (0-5)
Chafarinas	0				
N Morocco	3	106.0 ± 2.6 (103.0-108.0)	86.3 ± 4.2 (83.0-91.0)	14.9 ± 0.5 (14.5-15.4)	1.7 ± 0.6 (1-2)
S Morocco	14	107.1 ± 1.2 (105.5-109.0)	83.4 ± 2.4 (80.5-87.0)	15.0 ± 1.0 (13.9-17.3)	0.9 ± 1.1 (0-3)

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			-0.05 ± 0.42 (4)			
Retraps >1 day			0.13 ± 0.32 (3)			

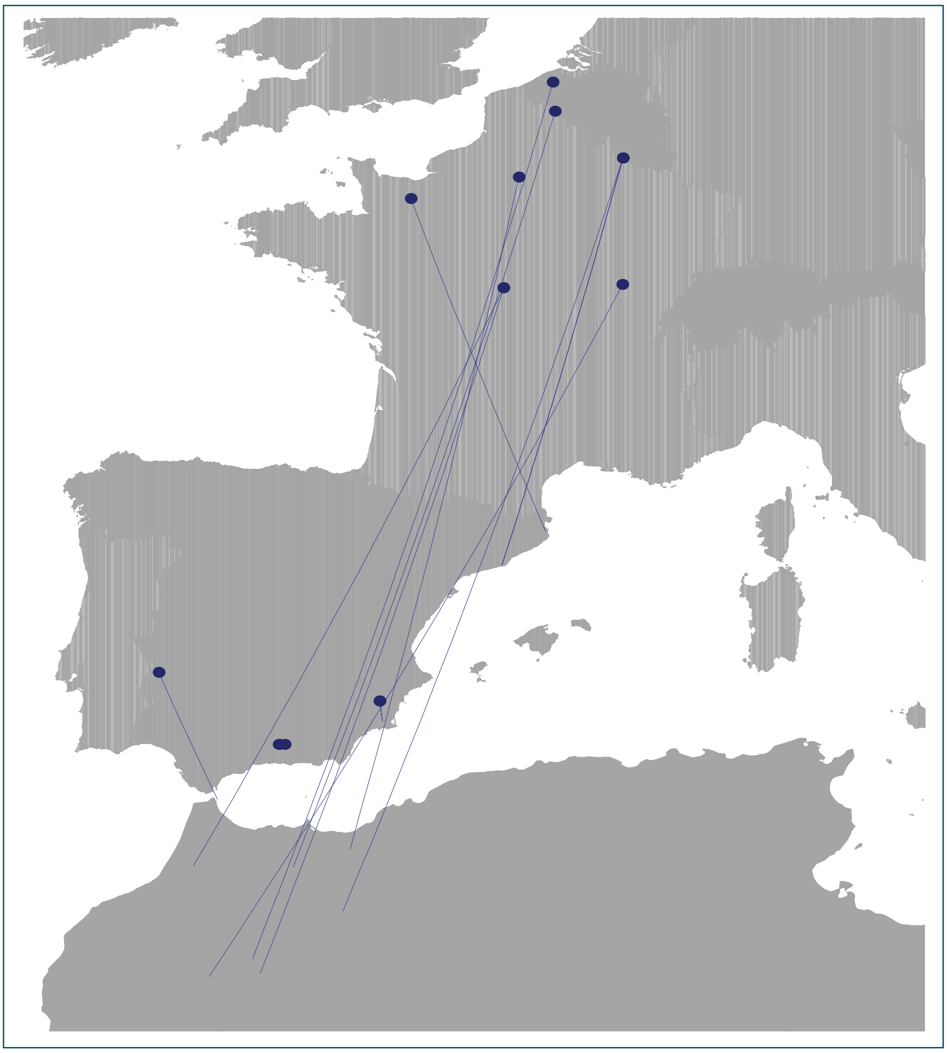


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

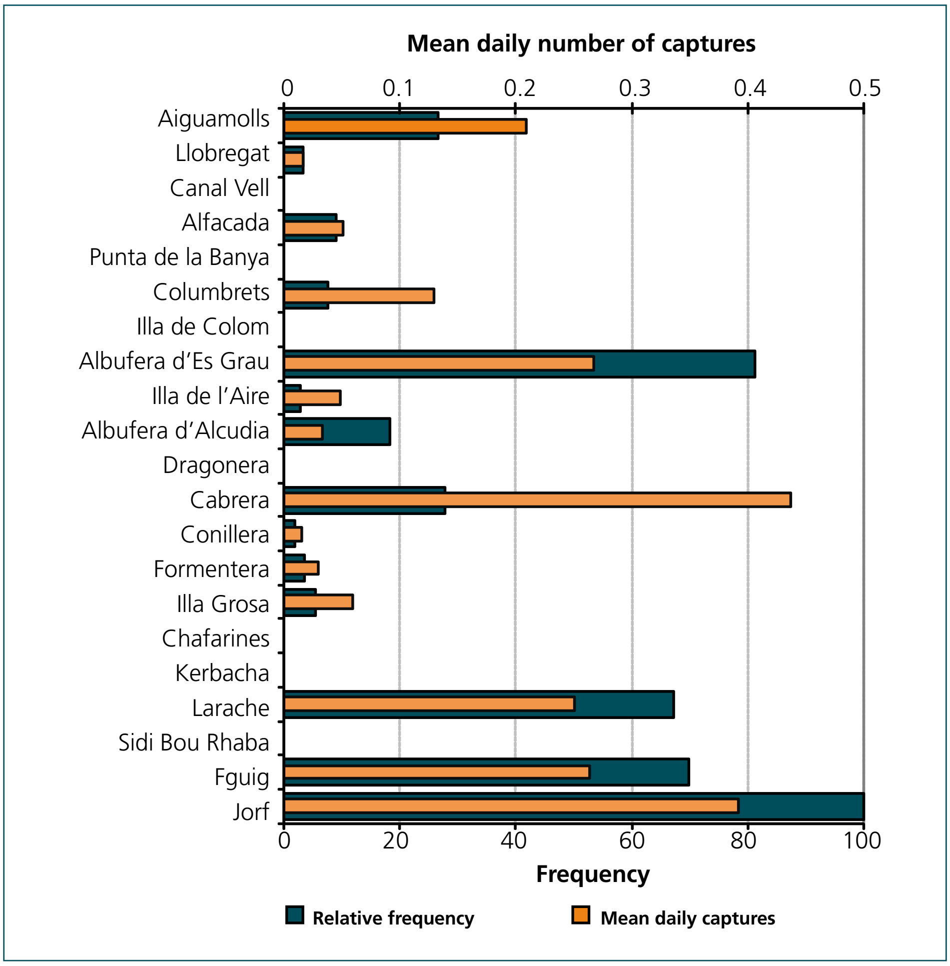


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

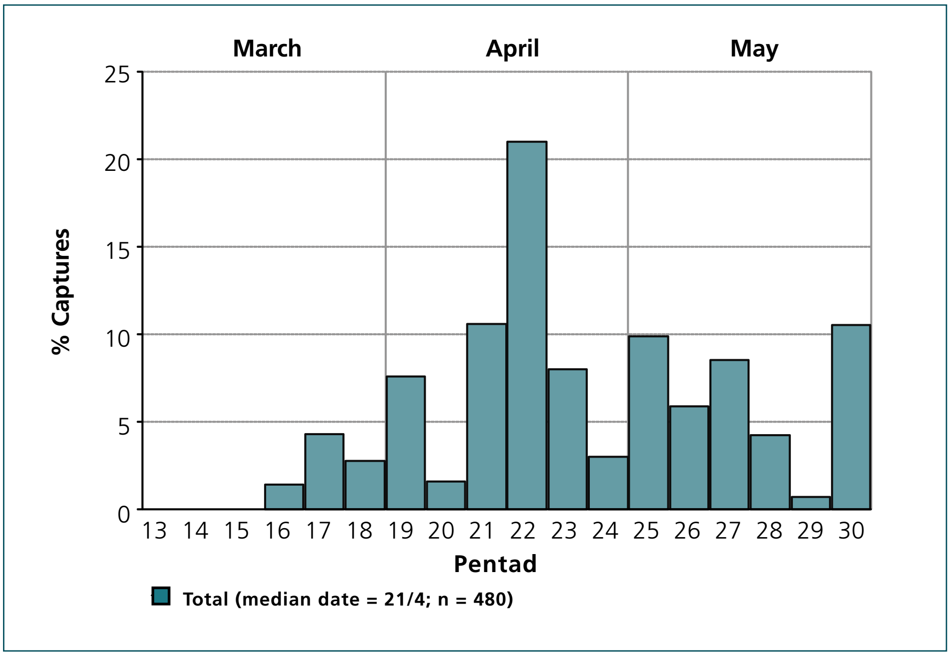


Figure 3. Frequency of captures during the study period.

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

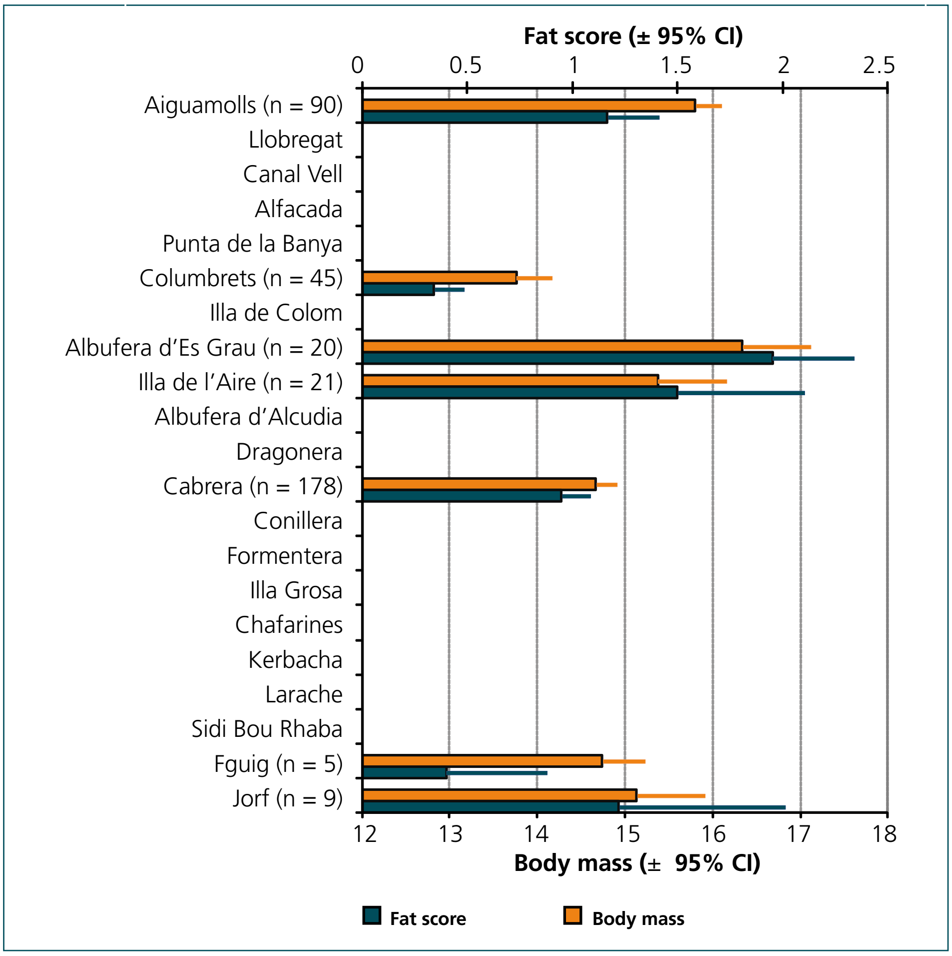
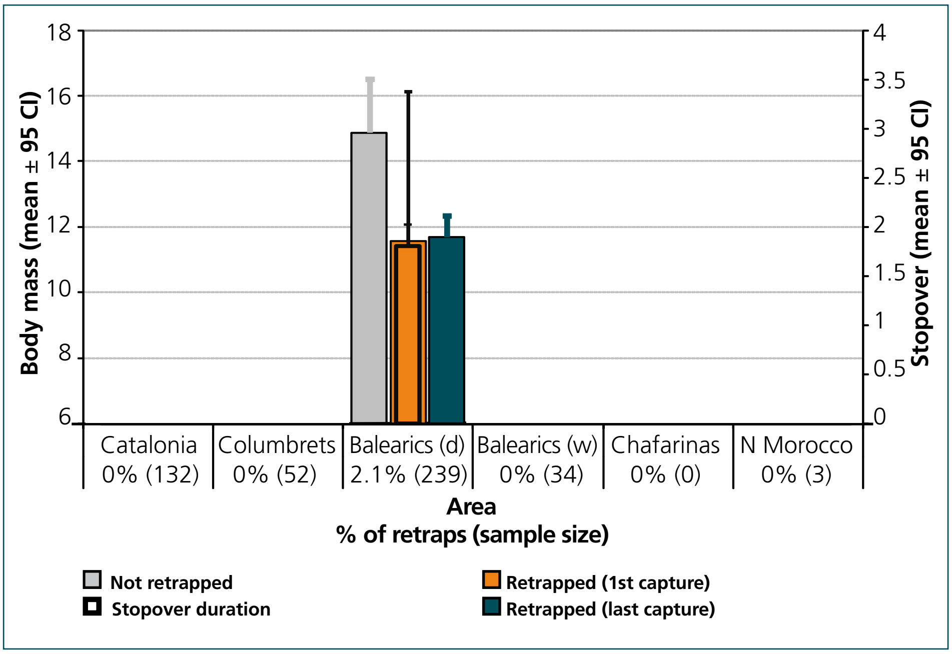


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



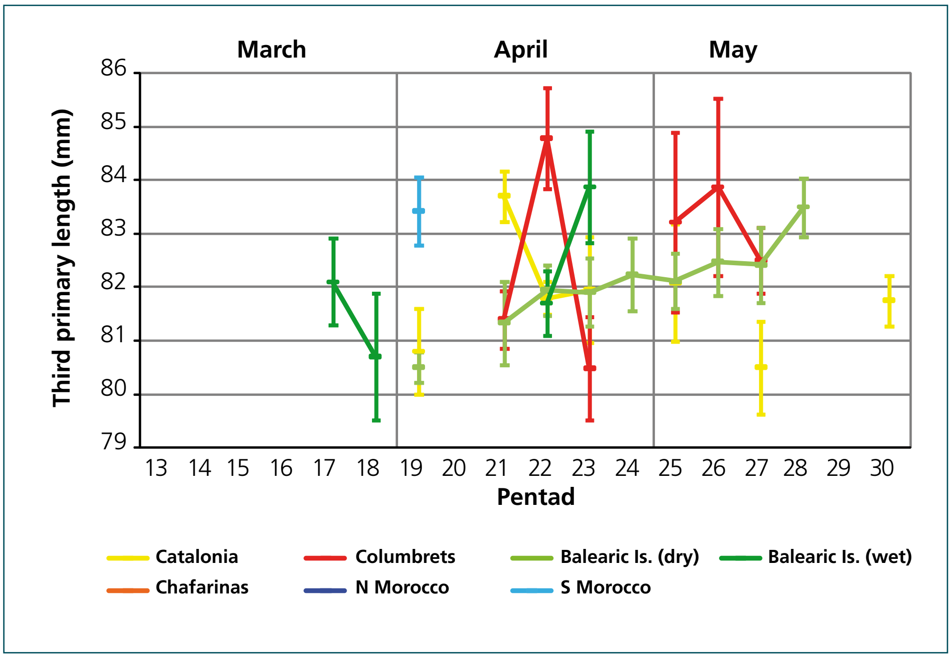


Figure 6. Temporal variation of third primary length according to area.

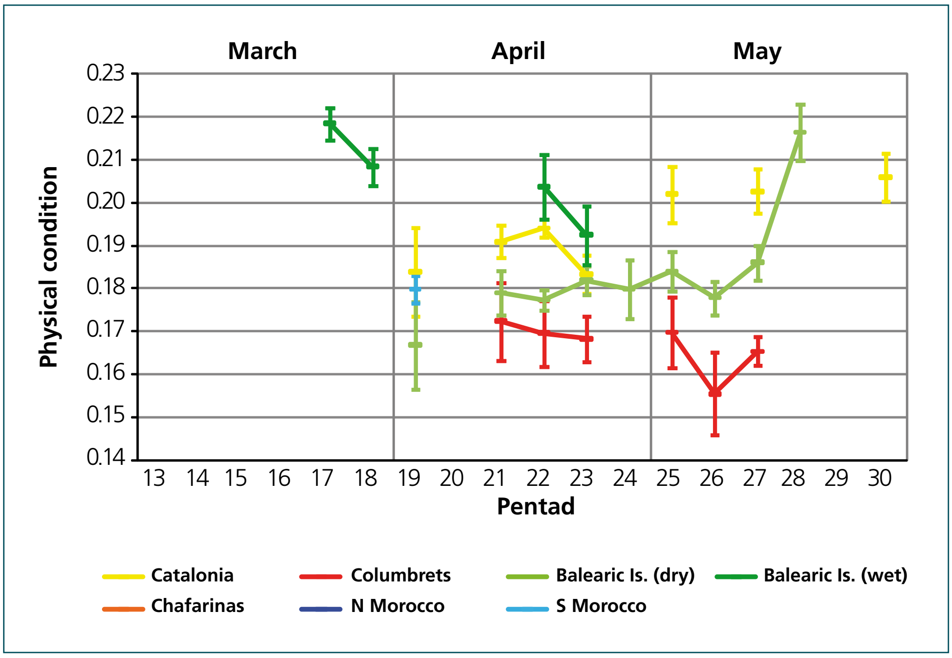


Figure 7. Temporal variation of physical condition according to area.

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

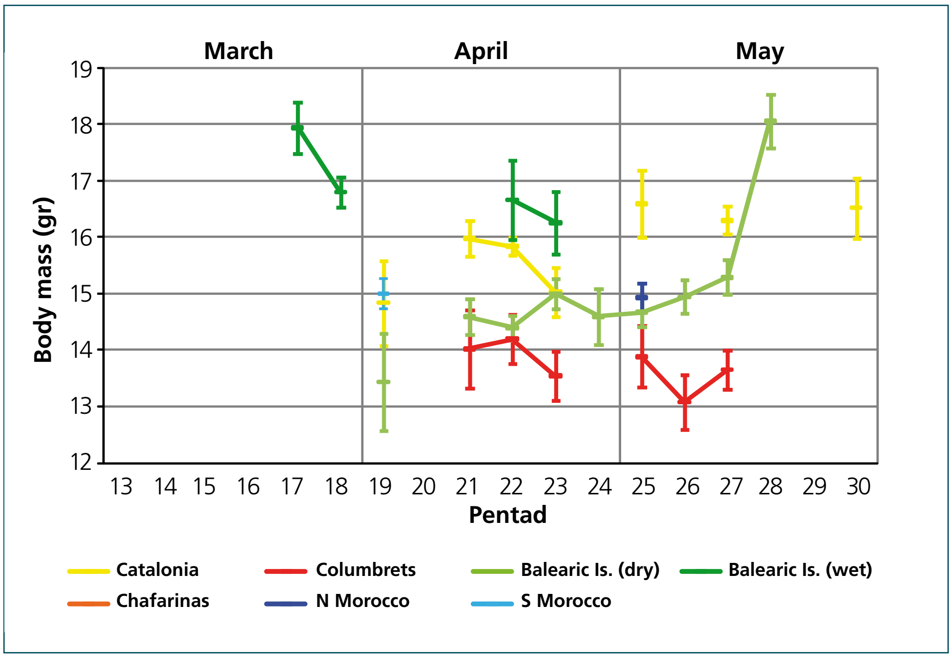
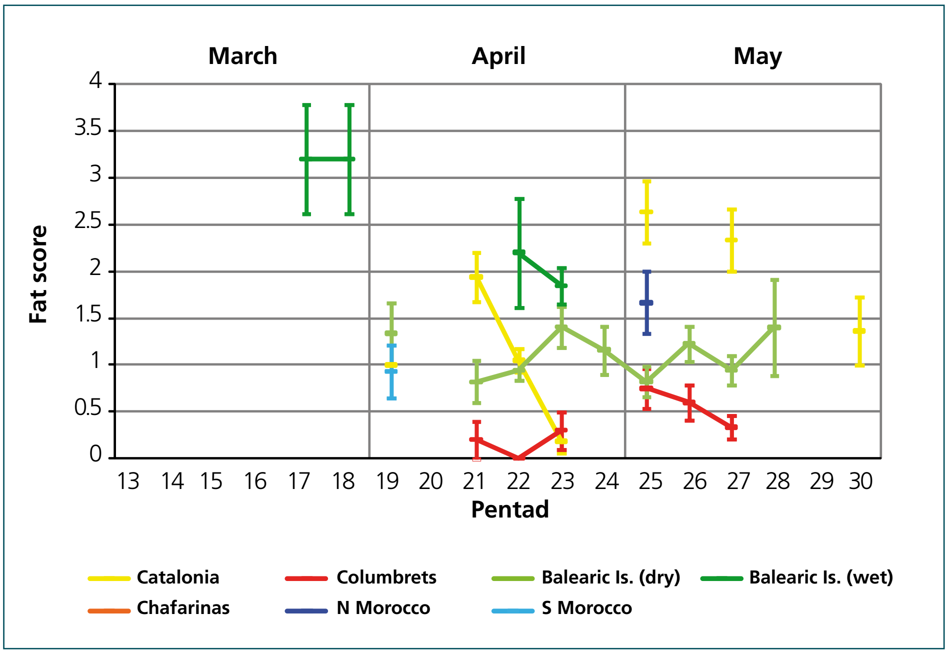


Figure 9. Temporal variation in fat score according to area.



Tree Pipit

Anthus trivialis

Joan Carles Fernández

Range

The Tree Pipit breeds patchily throughout most of S Europe, but is more widespread in C and N Europe and extends eastwards to *c.* 140°E and south to N Iran and NW Himalayas (Cramp, 1988). It winters irregularly in the E Mediterranean and parts of Arabia, and otherwise right across the Afrotropics and Indian subcontinent. The main wintering area in Africa extends across from the Guinean coast at 10°N to Ethiopia in the west and south to the northern edge of equatorial rain forest, although in the east it also extends south to Natal and Transvaal (Cramp, 1988). It does not breed at any of the ringing sites.

Migratory route

The few recoveries available show a main N-NE migration direction (fig. 1). The recovery in Catalonia of a bird breeding in Hungary shows that there is also a degree of influx of birds from E Europe, as occurs in autumn (Zink, 1975). A couple of recoveries in Morocco agree with the known preference for inland sites in this region (Thévenot et al., 2003).

Most captures and the greatest frequencies of captures occur on islands (fig. 2), indicating that good numbers of Tree Pipits cross the Mediterranean Sea. In fact, this species is more common in the Balearics in spring than in autumn. All captures from Morocco come from southern oases where the species is particularly common in spring; otherwise, in Morocco it is more widespread in spring than in autumn.

Phenology

The first individuals pass though the study area during the last two weeks of March, although the main passage period occurs between early April and mid-May (fig. 3). Two peaks are observed: one in mid-April and the other in early May, in contrast with the unimodal tendency recorded at Eilat in the E Mediterranean (Morgan & Shirihai, 1997). Some birds may still pass through Spain and Morocco in early June (Telleria et al., 1999; Thévenot et al., 2003). In S Morocco some migrants arrive in January or February, but only usually from March onwards; the passage period in Morocco is similar to that given here, with most birds passing through in April and numbers falling off by mid-May (Thévenot et al., 2003).

When analysing the common period (16 April to 15 May), the median dates of passage at the different study sites range from 25 April to 30 April, very similar to the overall median period recorded in the C Mediterranean (27 April; Rubolini et al., 2005); this suggests that simultaneous passage occurs throughout the Mediterranean as proposed by Cramp (1988). The median date of passage of second-year birds occurs four days later than in adults (fig. 3).

Biometry and physical condition

Mean third primary length ranges from 65.8 on Las Chafarinas to 69.6 in S Morocco, but is mostly around 66-67, marginally lower than in the spring migrants trapped in the C Mediterranean (mean 67.7, n = 454; Spina et al., 1993). The mean values of wing length vary from 87.0 in the dry Balearics to 88.8 in S Morocco (table 1). Overall, these values are similar to those encountered in the C and E Mediterranean (Morgan & Shirihai,1997; Waldenström et al., 2004) showing, thus, little differences in size between the populations that cross the Mediterranean. The third primary length decreases with time (fig. 6), presumably due to an earlier passage of longer-winged males (Cramp, 1988; Morgan & Shirihai, 1997).

Overall, mean fat scores are somewhat higher in the study area than in the Tyrrhenian islands (Spina et al., 1993), with values ranging between 0.7 on Las Chafarinas and 2.9 in the wet Balearics. Mean body mass varies from 19.7 on Els Columbrets to 22.1 in the wet Balearics (table 1), distinctly higher than that reported on islands of the C Mediterranean (mean 18.0, n = 454; Spina et al., 1993). Birds on Els Columbrets show significantly lower mean body mass than in Catalonia and the dry Balearics; mean fat and physical condition are lower on Els Columbrets than in Catalonia and Balearics. No overall temporal trends are observed for body mass and fat but physical condition increases significantly with time.

The highest average body mass is found in mainland areas (Catalonia) and the wet Balearics, suggesting that these areas offer better habitat for stopovers. Moreover, birds migrating through continental Spain are less energetically stressed than those crossing the sea, as exemplified by the very low body-mass figures from Els Columbrets, the most isolated island and the most distant from N Africa in this study, and from the Tyrrhenian islands.

The few birds captured in S Morocco are fairly heavy, contrasting with available data from nearby sites: Defilia (mean 18.2, n = 51; Ash, 1969) and Merzouga (mean 18.7, n = 14; Gargallo et al., unpubl.). This suggests that body condition can vary largely from year to year or possibly according to the nature of the habitat. Body mass reported in N Tunisia (mean 23.5, n = 10; Waldenström et al., 2004) is distinctly higher, suggesting some mass gain can take place in NW Africa prior to migration to Europe.

Stopover

In all areas with data the proportion of retraps is quite low (fig. 5). In the dry Balearics, the initial body mass of retrapped birds is significantly lower than in those not trapped again, suggesting that a higher proportion of birds in poor condition select to stay on these islands (table 2). Retraps of more than one day indicate that even in sites such as Els Columbrets birds have significant positive fuel deposition rates. These results suggest that, unlike most other species, Tree Pipits can benefit from the refuelling opportunities offered by the typical open habitats of small Mediterranean islands.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	53	87.4 ± 2.9 (81.0-97.5)	67.2 ± 2.6 (60.0-73.0)	21.6 ± 2.5 (16.2-27.6)	2.4 ± 1.3 (0-5)
Columbrets	190	87.5 ± 2.7 (82.0-95.0)	66.3 ± 2.2 (61.0-73.0)	19.7 ± 3.1 (13.6-27.8)	1.3 ± 1.2 (0-5)
Balearics (dry)	609	87.0 ± 2.7 (79.0-97.0)	66.9 ± 2.4 (59.0-74.0)	20.7 ± 2.6 (14.4-28.7)	1.9 ± 1.5 (0-7)
Balearics (wet)	8	87.6 ± 4.2 (79.5-93.0)	67.0 ± 4.2 (59.0-72.5)	22.1 ± 1.7 (19.5-24.4)	2.9 ± 1.5 (1-5)
Chafarinas	3		65.8 ± 0.8 (65.0-66.5)	19.8 ±2.7 (18.2-23.0)	0.7 ± 1.2 (0-2)
N Morocco	0				
S Morocco	5	88.8 ± 1.2 (87.0-90.0)	69.6 ± 1.6 (67.0-71.0)	21.6 ± 2.3 (18.3-24.6)	1.4 ± 0.5 (1-2)

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 ± 0.84 (2)	0.37 ± 0.63 (8)	0.12 ± 0.19 (56)			
Retraps >1 day		0.52 ± 0.15 (4)	0.33 ± 0.13 (42)			

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

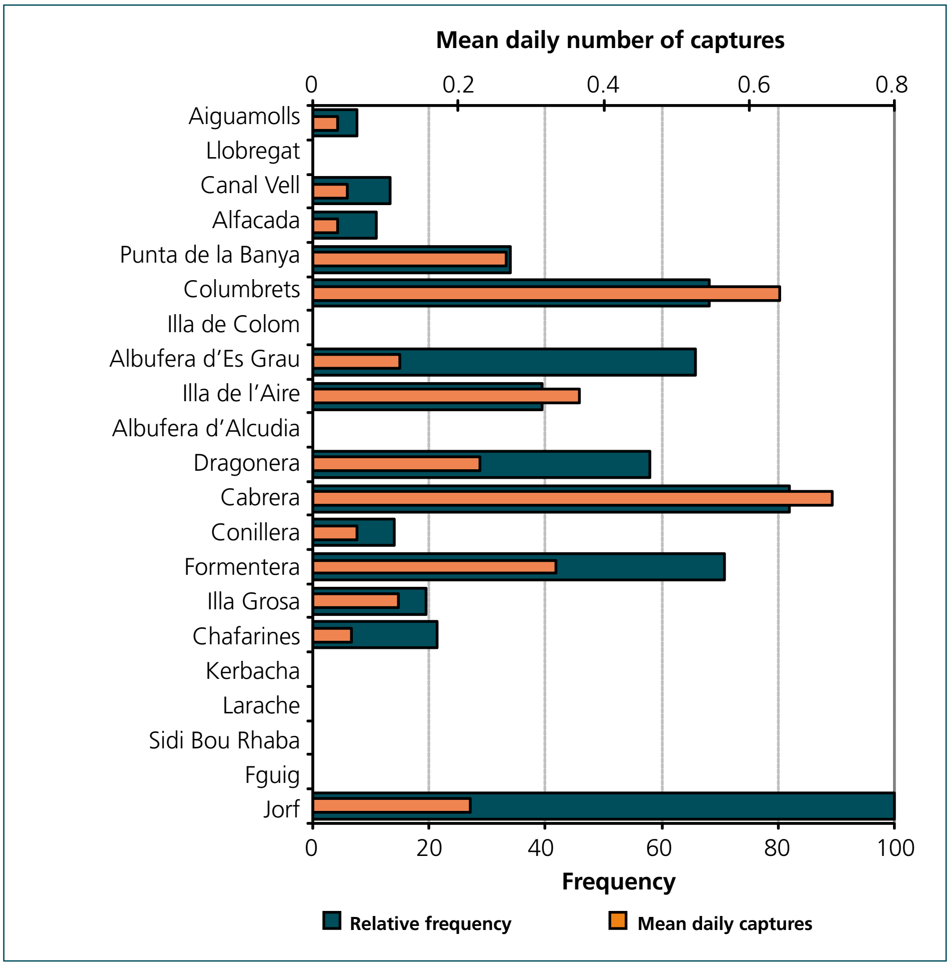


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

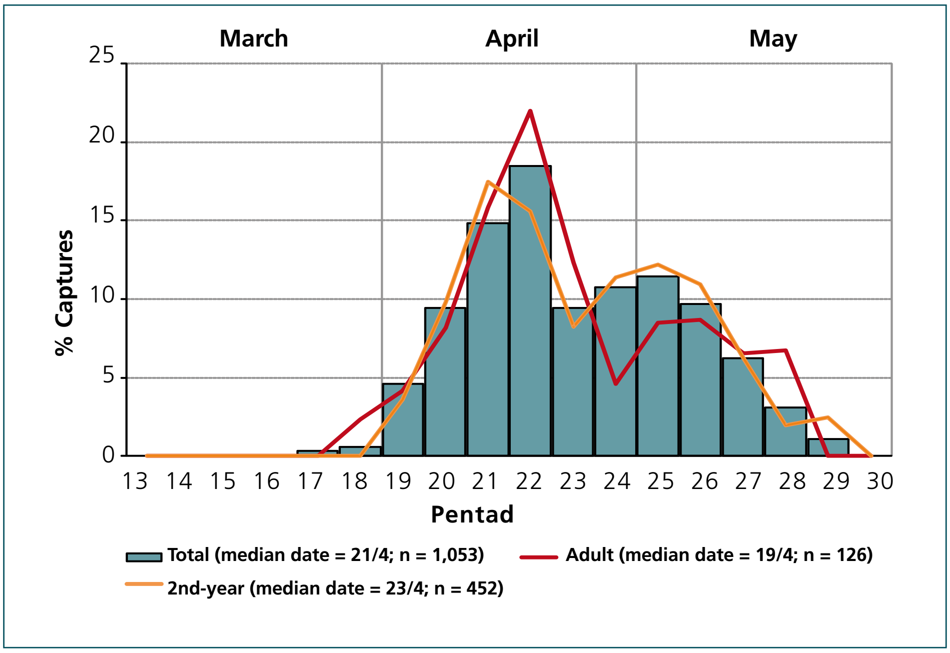


Figure 3. Frequency of captures during the study period.

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

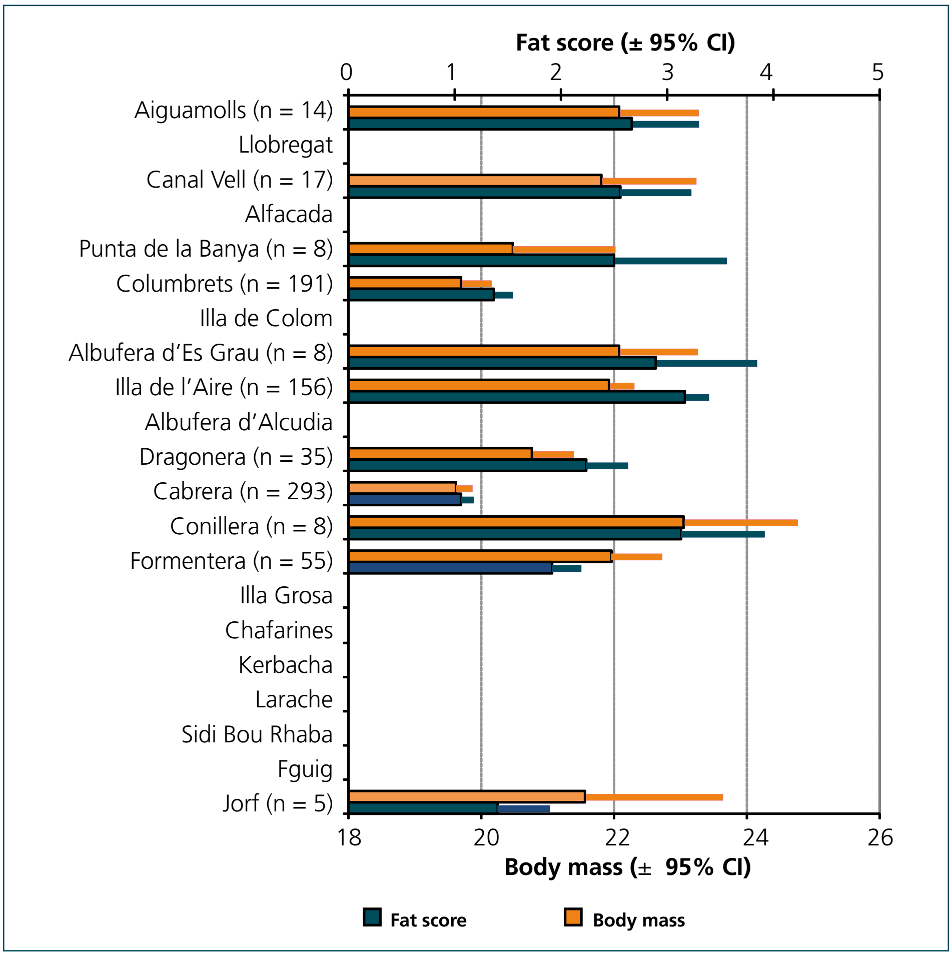
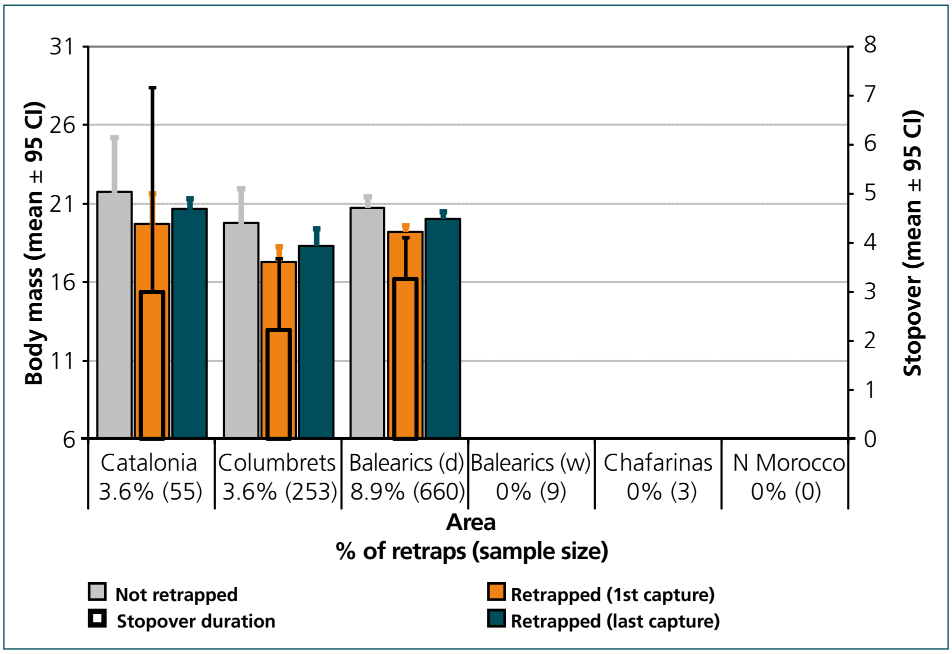


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



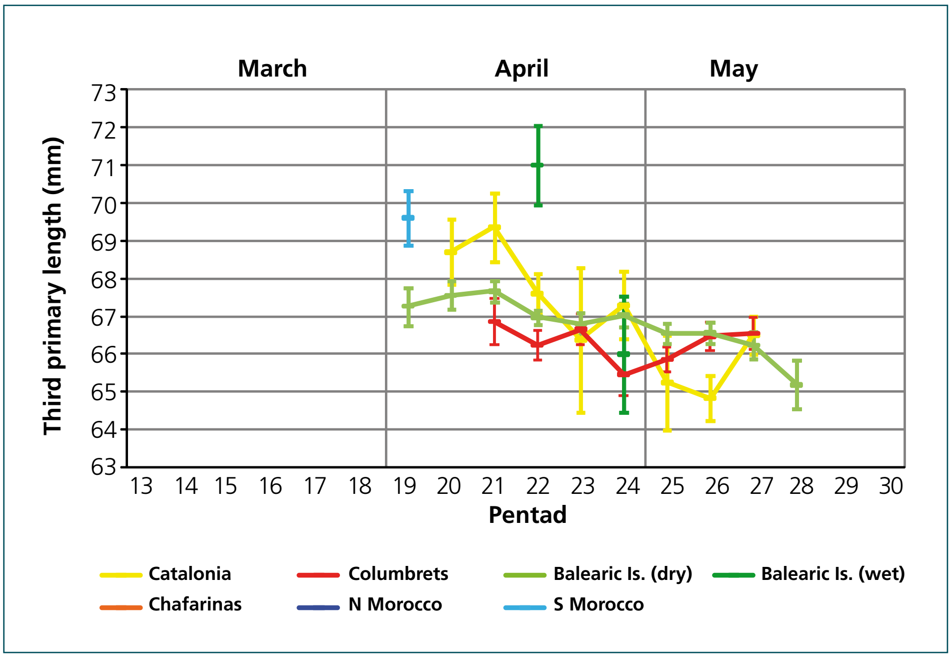


Figure 6. Temporal variation of third primary length according to area.

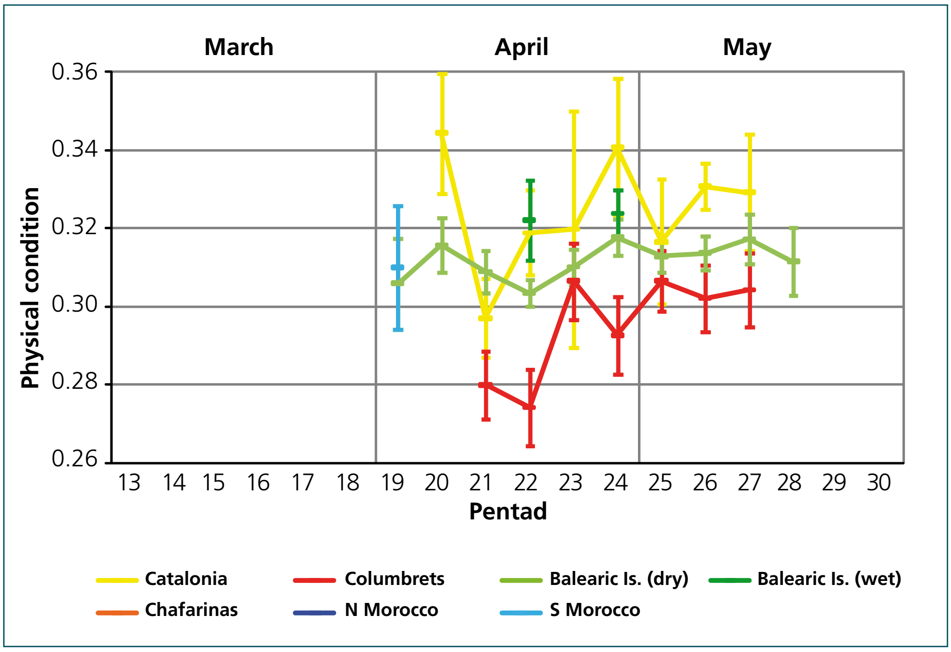


Figure 7. Temporal variation of physical condition according to area.

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

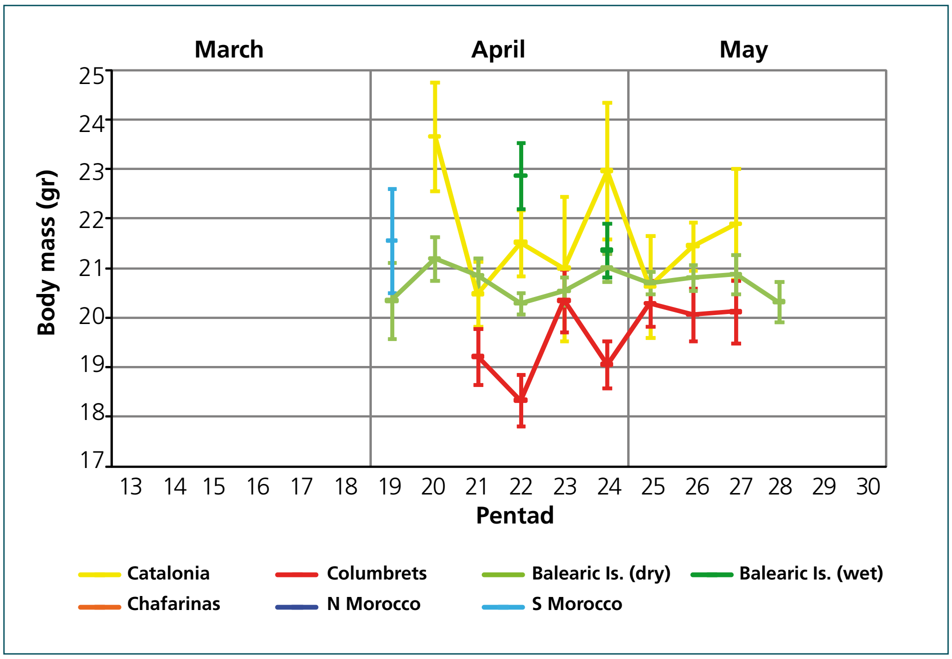
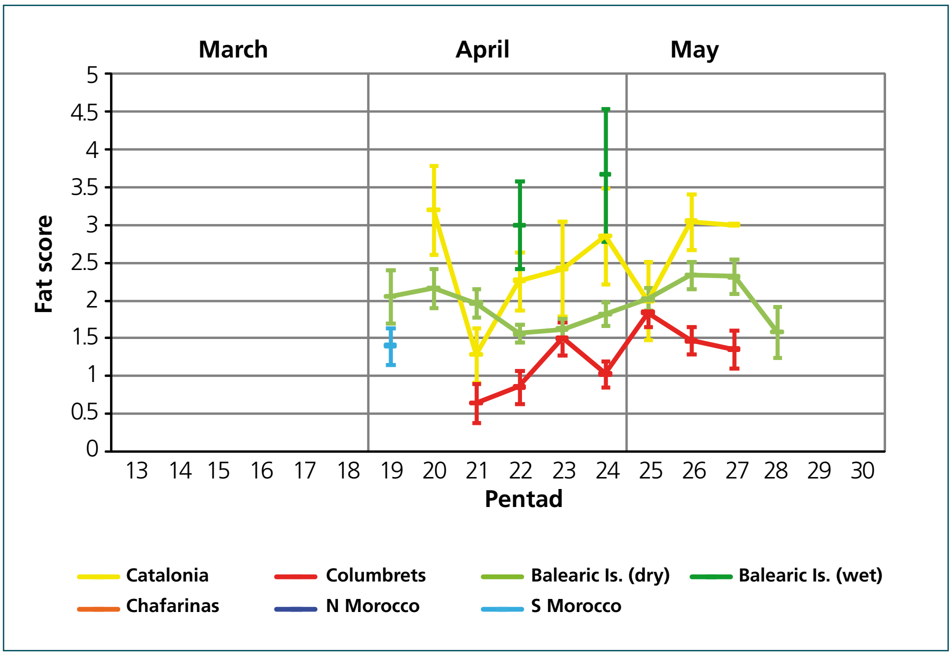


Figure 9. Temporal variation in fat score according to area.



Yellow Wagtail

Motacilla flava

Carles Barriocanal & David Robson

Range

The Yellow Wagtail is a polytypic species that breeds throughout almost the entire Palearctic, although only patchily in N Africa and SW Europe (Cramp, 1988; Hagemeijer & Blair, 1997). The nominate race *flava* occurs in most of Europe, while *iberiae* breeds in the western Mediterranean (SW France, Iberia and the Balearic Islands, and NW Africa). These are the two most numerous races found on migration in the study area, followed by *flavissima* (UK and NW Europe) and *thunbergi* (N Europe, from Norway eastwards). The other races are present in very low numbers (Aymí & Martinez, 1990). This wagtail is a long-distance migrant, although populations in N Africa and possibly S Spain overwinter in part on their breeding grounds (Cramp, 1988; Telleria et al., 1999; Thévenot et al., 2003). Wintering areas are to be found in the Afrotropics (European populations), India and SE Asia (Cramp, 1998).

Although this wagtail breeds in some of the wetlands in Catalonia and the wet Balearics, migrants form the bulk of captures even at these sites (the exception being Els Aiguamolls de l'Emporda, where late in the season local birds dominate).

Migratory route

Recoveries indicate that birds cross the study area following a rather variable axis of movement (fig. 1): the majority move in a SW-NE direction, although some move more due N or even towards the NW. Only two direct recoveries are available: one bird was captured in coastal E Spain at the beginning of May and then recovered two months later in Sweden, 3.000 km further NNE, while another bird was ringed at the end of May in Cadiz (S Spain) and then recovered in November in Senegal. In spring Yellow Wagtails pass through the study area following a more easterly route than in autumn (Cramp, 1988; Telleria et al., 1999; Wernham et al., 2002; Wood, 2002). This longitudinal shift ensures that western Spain and Portugal, where many birds (particularly British ones) pass through in autumn, are largely devoid of birds in spring; likewise, the species is also relatively more frequent in E Morocco in spring than in the west. Recoveries showing NW movements (fig. 1) exemplify the return route followed by some British birds using this more easterly flyway.

The number and frequency of captures in both the Balearics and on Els Columbrets are similar or even higher than at continental sites in NE Spain, suggesting that the species does not avoid crossing large stretches of the Mediterranean Sea (fig. 2). In fact, passage seems to take place across a broad front in both autumn and spring and also when crossing the Sahara (Cramp, 1988). The number of captures is highest in S Morocco (fig. 2), where the species is very common in spring (Ash, 1969; Cramp, 1988).

Phenology

Spring passage starts at the end of March, reaches a peak in late April and early May and then decreases progressively towards the end of May (fig. 3). It should be taken into account that during the second half of May passage seems more intense than it really is due to the inclusion of a significant number of local breeding birds in Catalonia. This overall pattern of passage is quite similar to that described for S France (Blondel & Isenmann, 1981) and Italy (Spina et al., 1993; Spina & Volponi, 2009), but is somewhat delayed with respect to S Spain and Morocco. Moreover, other observational data from Catalonia (ICO, 2010) indicates that in this area passage occurs, although in low numbers, already from late February and early March. In the S Iberian Peninsula migration takes place somewhat earlier than shown here, starting as early as February and with the main passage period occurring in April (Telleria et al., 1999; Finlayson, 1992). In Morocco, passage is also clearly more advanced, with some birds passing through already in early February and peaking between late March and late April (Thévenot et al., 2003). Some migrants are known to still be actively migrating through the W Mediterranean even in late June (Cramp, 1988; Telleria et al., 1999; Thévenot et al., 2003).

Males pass earlier than females (median date four days earlier; fig. 3) and adults earlier than second-year birds (median dates 27 April and 5 May respectively). This delay in female passage is very similar to that reported in Italy during spring migration (Rubolini et al., 2004), but much less obvious than the delay in arrival at breeding grounds (females *c.* 1-2 weeks later; Cramp, 1988). These differences probably reflect the misleading effects caused by the passage of several subspecies through stopover sites. In Nigeria, spring pre-migratory fattening of males occurs *c.* 10 days earlier than in females (Wood, 1992).

Recoveries from the study area show that the later the birds pass through the W Mediterranean the further north they migrate. This finding agrees with the later passage observed for more northern races (*e.g. thunbergi*; Cramp, 1998) and seems to be caused by a leap-frog migration pattern, whereby the northernmost breeding individuals and females tend to winter further south (Cramp, 1988; Wood, 1992).

Biometry and physical condition

Mean values of third primary length range from 59.0 in S Morocco to 61.1 in N Morocco, while mean values of wing length vary from 78.8 in the wet Balearics to 81.0 in N Morocco (table 1). Overall, these values are slightly below those reported in the C Mediterranean (mean third primary length 61.6, n = 141; Spina et al., 1993) and E Mediterranean (Morgan & Shirihai, 1997), but within the range reported in Cramp (1988). The third primary length remains fairly constant throughout the season except in dry Balearics where it tends to decrease significantly (fig. 6). A similar pattern is reported in the Tyrrhenian islands (Spina et al., 1993) and similarly may reflect the early passage of distinctly larger males (Cramp, 1988).

Mean fat scores range between 1.0 on Els Columbrets and 3.5 in N Morocco, although mostly lie between 1 and 2; body mass ranges between 14.5 on Els Columbretes and 18.2 in the wet Balearics (table 1). Fat scores tend to decrease in all areas, although only significantly so in Catalonia (fig. 9); body mass and physical condition do not show any clear temporal patterns (figs. 7-8), just as in the C Mediterranean (Spina et al., 1993). The body mass of birds trapped on islands in the C Mediterranean (mean 13.9, n = 141; Spina et al., 1993) is slightly lower than on Els Columbrets, but distinctly lower (c. 14% lower) than in the dry Balearics. In fact, the maximum values of mean body mass in the C Mediterranean are close to the lowest figures reported here for the W Mediterranean, with the exception of Els Columbrets. These differences show that birds with the highest levels of energetic stress are those that cross the largest geographical barriers; of all birds, those caught on Els Columbrets (the most distant island from N Africa of those in the study area) and those caught on the islands of the C Mediterranean face the longest desert and sea crossings.

Birds captured in Catalonia are distinctly heavier than those from the dry Balearics, while those on Els Columbrets are the lightest (fig. 6). Although the sample is small, birds from the wet Balearics have similar mean body mass to Catalonia, suggesting that on islands with suitable habitat (*e.g.* wetlands) birds can regain some mass lost during sea crossings. The mean body mass in S Morocco is quite high compared with that reported at the tiny nearby oasis of Defilia (mean 14.6, n = 194; Ash, 1969) and Merzouga (mean 15.4, n = 42; Gargallo et al., unpubl.). Mirroring the difference in mass found between the dry and wet Balearics, the lowest values reported in these tiny and less verdant oases (or islands) may reflect poorer habitat suitability and thus fewer possibilities of regaining mass. On the other hand, these apparently poorer stopover areas may attract a higher proportion of birds in poor physical condition that are more likely to stop at the first available site. In any case, the range of mean body mass recorded in S Morocco is *c.* 8-18% lower than in the north of the country (table 1), suggesting that the species regains some mass in Morocco prior to moving on towards Europe. Although the sample size from N Morocco is too small to be conclusive, these findings agree with other published data suggesting that the species uses NW Africa to stopover and regain mass (Wood, 1992; Wernham et al., 2002).

Body mass in birds captured in spring in the Netherlands (mean 16.4, n = 26; Cramp, 1988) and W Germany (mean 16.2, n = 22; Cramp, 1988) is somewhat lower than in Catalonia and N Morocco, suggesting a progressive and slight depletion of reserves after leaving the Mediterranean Basin. These movements through continental Europe seem to coincide with a slowed progress of spring migration (Wood, 1992).

Stopover

Few retraps have been made (fig. 5, table 2). Moreover, in the case of Catalonia the presence of local breeding birds increases unrealistically the mean stopover length. The overall low percentage of retraps suggest that birds do not tend to stay more than one day at the study sites, although this may also reflect the low recapturability rate of this species due to its preference for open habitats where mist-nets are less effective. Birds retrapped in Catalonia –some of them undoubtedly local birds– do not show any significant change in mass, while those from the dry Balearics, where habitat is less suitable for feeding, have negative fuel deposition rates (table 2).

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	218	79.6 ± 2.7 (73.5-87.0)	60.9 ± 2.4 (54.5-66.5)	17.1 ± 1.5 (11.4-24.0)	1.8 ± 1.3 (0-5)
Columbrets	119	80.2 ± 2.9 (72.0-87.0)	60.0 ± 2.6 (51.0-66.0)	14.5 ± 2.1 (10.7-19.8)	1.0 ± 1.0 (0-4)
Balearics (dry)	207	79.7 ± 2.8 (73.0-88.0)	60.3 ± 2.5 (53.5-66.5)	15.9 ± 2.0 (10.5-22.3)	2.2 ± 1.4 (0-6)
Balearics (wet)	6	78.8 ± 2.5 (74.5-81.5)	60.3 ± 1.9 (56.5-62.0)	18.2 ± 0.9 (17.1-19.6)	1.2 ± 1.5 (0-4)
Chafarinas	0				
N Morocco	4	81.0 ± 2.2 (79.0-84.0)	61.1 ± 2.4 (58.5-64.0)	17.9 ± 3.2 (14.6-22.1)	3.5 ± 0.6 (3-4)
S Morocco	59	79.0 ± 3.3 (73.0-85.0)	59.0 ± 3.5 (50.0-64.0)	16.5 ± 1.3 (14.5-19.3)	1.5 ± 0.6 (1-3)

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 ± 0.29 (10)		-0.70 ± 0.60 (5)			
Retraps >1 day	-0.10 ± 0.32 (9)					

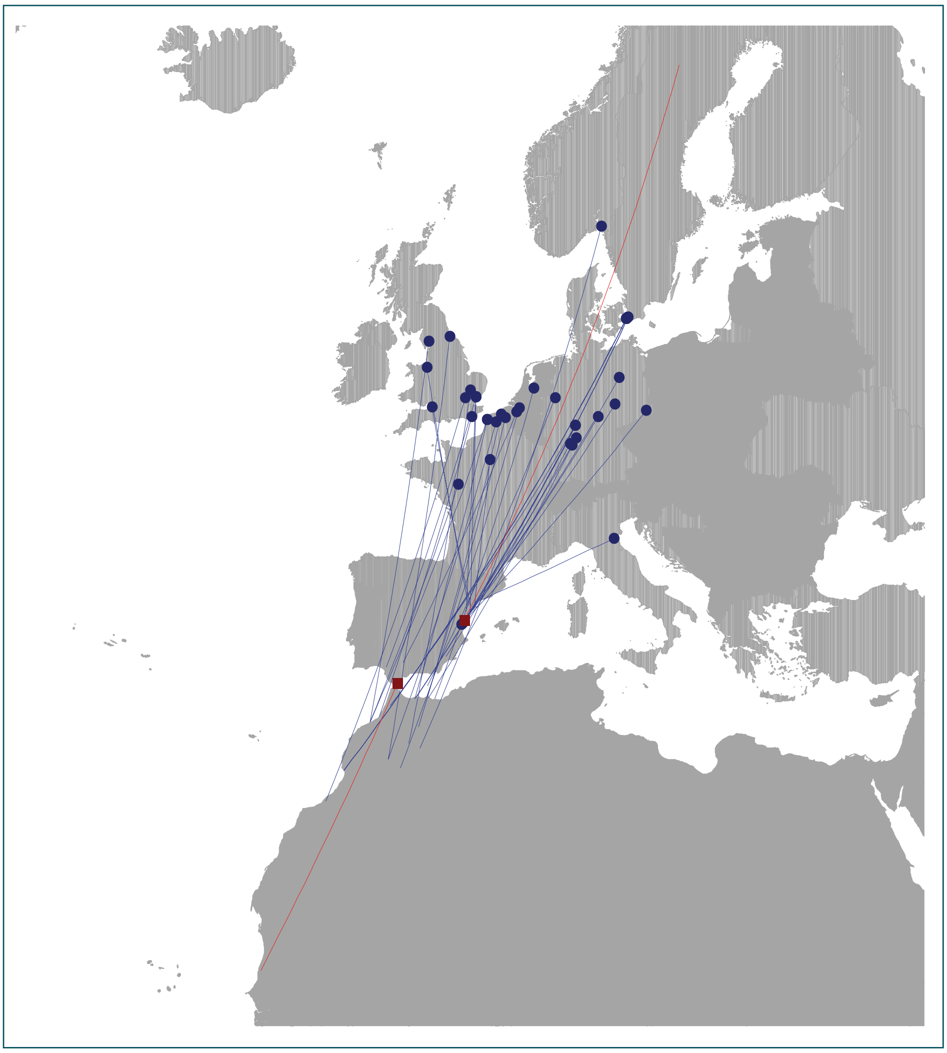


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

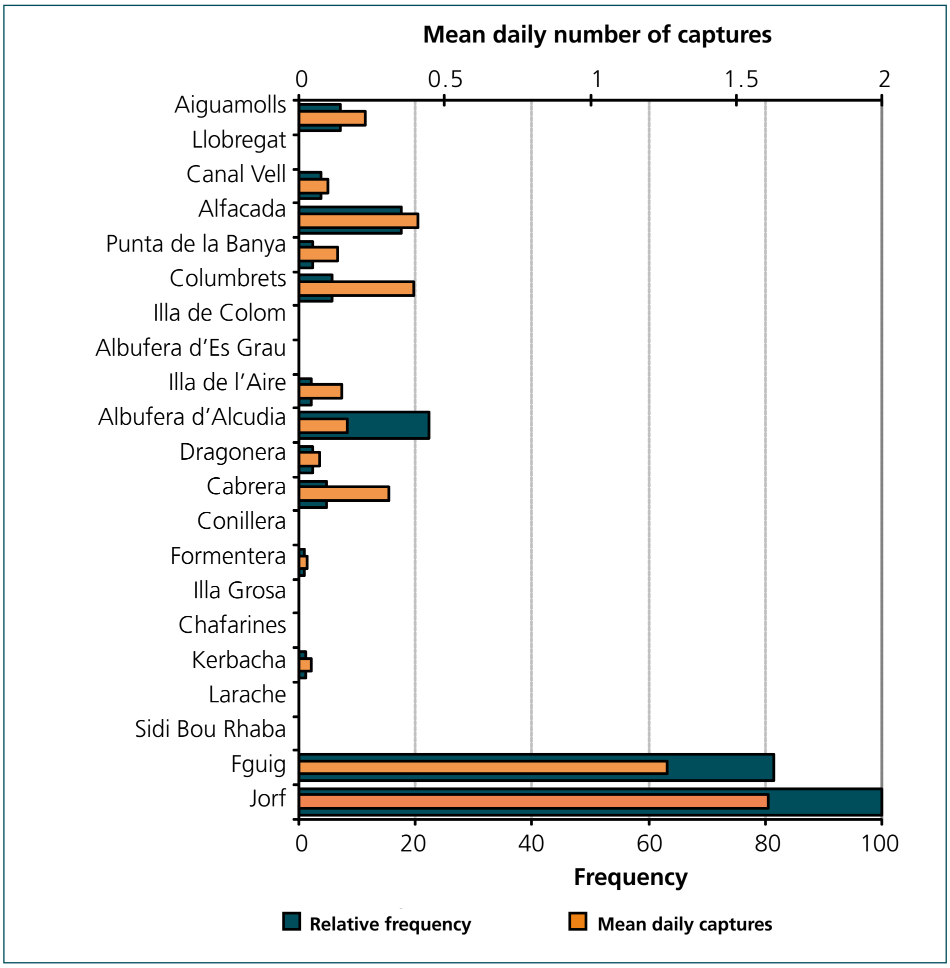


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

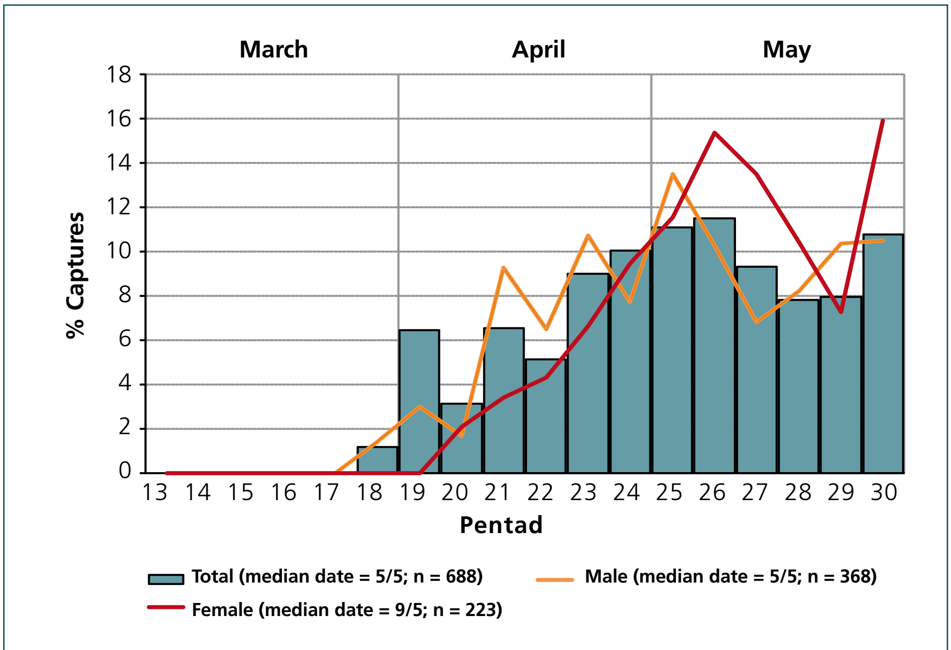


Figure 3. Frequency of captures during the study period.

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

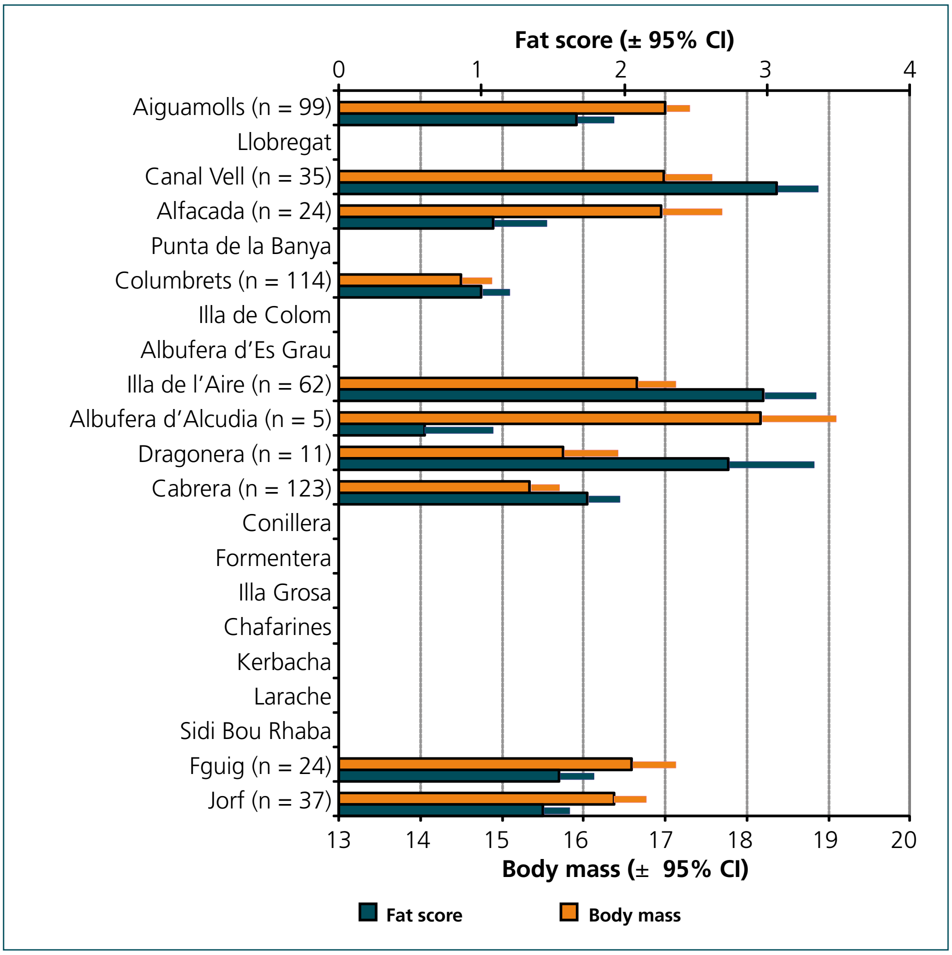
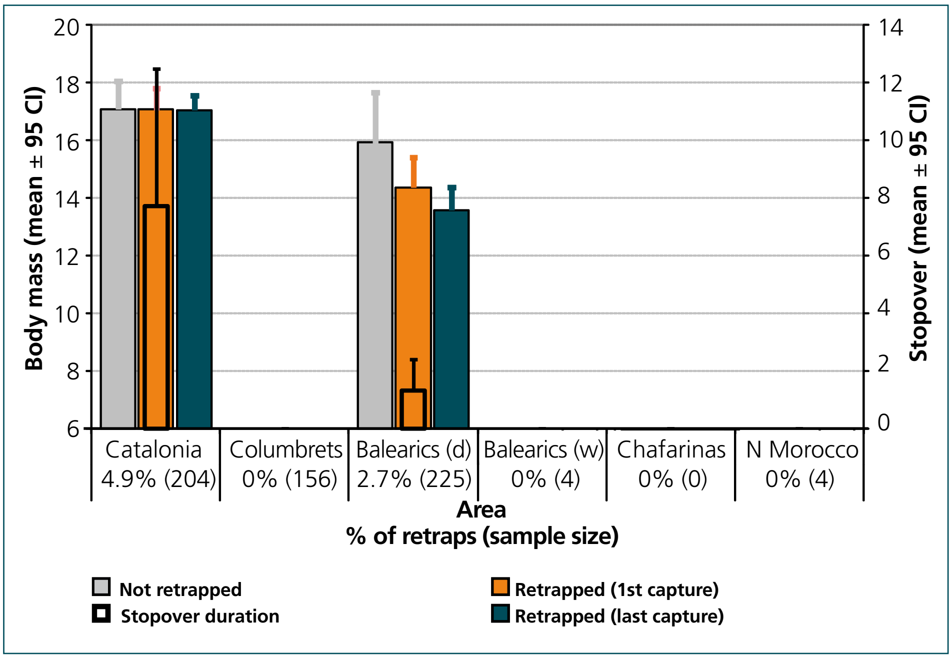


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



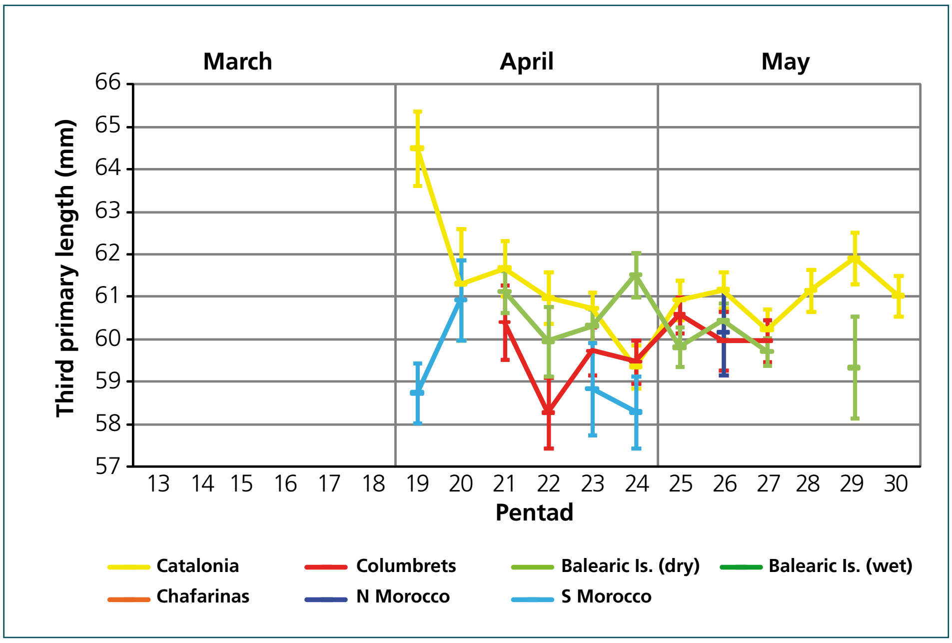


Figure 6. Temporal variation of third primary length according to area.

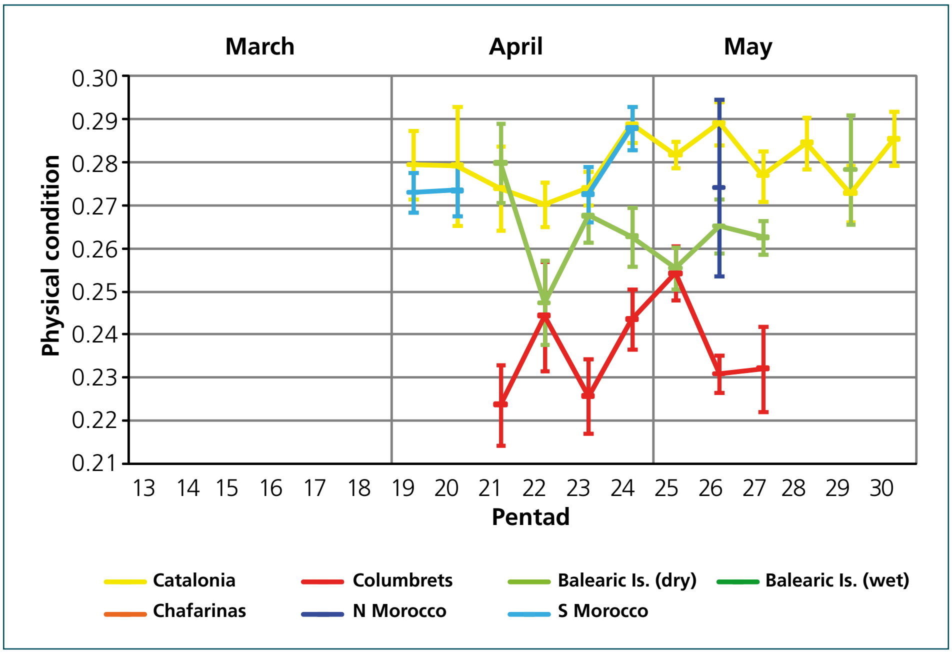


Figure 7. Temporal variation of physical condition according to area.

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

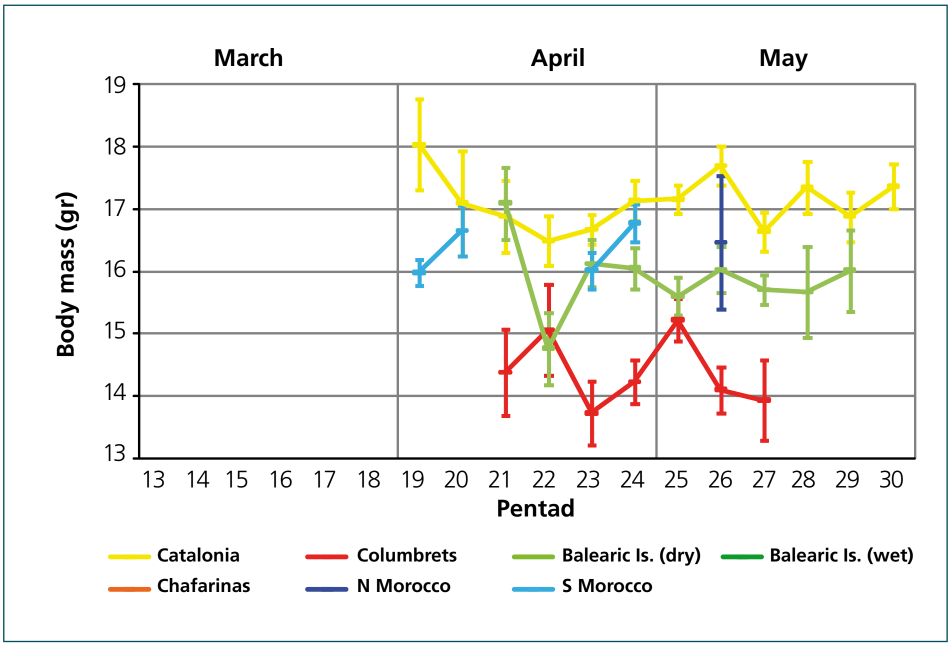
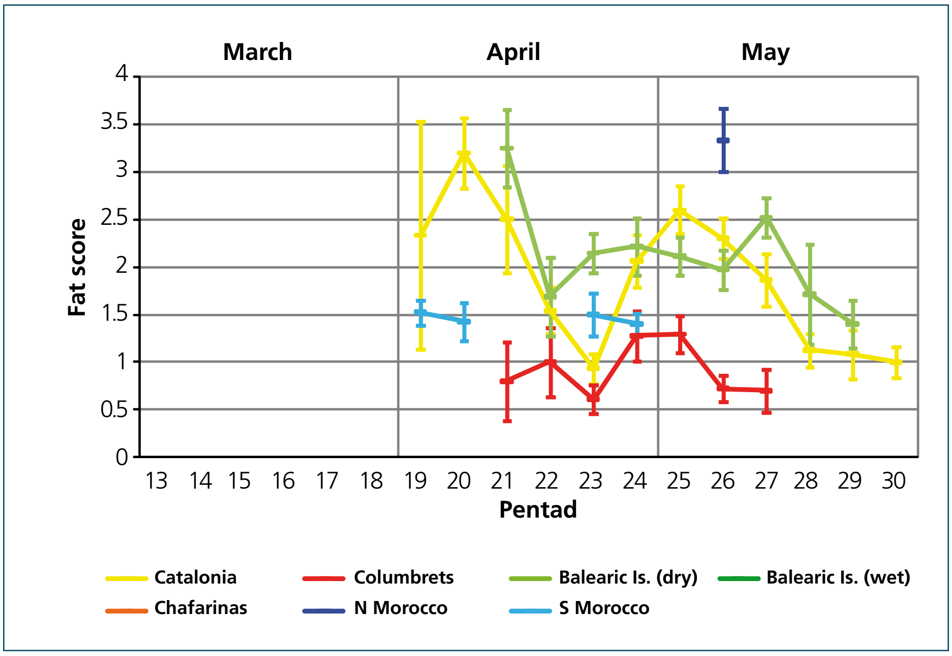


Figure 9. Temporal variation in fat score according to area.



European Robin

Erithacus rubecula

José Ignacio Dies

Range

The European Robin is a polytypic species with up to eight races showing slight clinal changes in size and colour, which breeds from Atlantic Europe south to N Africa and east to W Siberia and N Iran (Cramp, 1988). Most populations are partially migratory, although Robins are totally migratory in the north-east and probably largely sedentary in the extreme south. There are notable winter concentrations in the Mediterranean Basin, but it is scarce in N Africa south of the coastal strip and rare below 32°N (Cramp, 1988; Adriaensen & Dhondt, 1990; Pérez-Tris et al., 2000; Thévenot et al., 2003). As a consequence of differential migration, female European Robins outnumber males in southern wintering regions since the species shows a strong latitudinal segregation of the sexes (Catry et al., 2004a).

The Robin does not breed at any of the study sites, but is a common wintering species in the wet Balearics, N Morocco, Catalonia and on the larger islands of the dry Balearics (Cabrera, Formentera), although even there the majority of birds are migrants. In S Morocco and on the smallest islands no or very few wintering birds are present (L'Illa de l'Aire, Conillera, Els Columbrets, L'Illa Grossa and Las Chafarinas).

Migratory route

Ringing recoveries show a prevailing SW-NE direction in birds of the nominate *rubecula* range (fig. 1). There are two recoveries from southern Great Britain, possibly corresponding to the race *melophilus*, despite a lack of recoveries of this taxon from outside its range (Wernham et al., 2002). Recoveries reach 61°N in the Scandinavian Peninsula and NW Russia, but do not occur far from the coast in Morocco and Algeria; the southernmost recoveries are at 32°N in NW Morocco.

The frequency and number of captures is lowest in Morocco and on Las Chafarinas, although similar values are found along the coast of the Iberian Peninsula and the Balearic Islands (fig. 2); the sole exception is Illa Grossa, which accounts for a large proportion of captures, probably due both to an important influx of migrants to coastal Spain and the island effect.

Phenology

Migration through the W Mediterranean starts before the beginning of the study period, that is, usually early and mid-February (Cramp, 1988; Bueno, 1998; Tellería et al., 1999; Thévenot et al., 2003). During early March the influx of birds is still low and the main passage period occurs between mid-March and early April (fig. 3). Data from Els Columbrets and L'Illa de l'Aire, where wintering birds are very scarce, confirm this phenological pattern. Adults tend to pass marginally earlier than second-year birds, a pattern that is repeated in Catalonia and on the Balearics (little data available from Morocco). In accordance with published data (Cramp, 1988), passage decreases markedly during the second half of April and only a few stragglers occur as late as early May (fig. 3). In the Tyrrhenian Islands, however, spring migration is largely finished by the end of March (Pettersson et al., 1990; Spina et al., 1993).

Biometry and physical condition

Mean third primary length ranges from 52.5-52.6 in Morocco to 54.5 in Catalonia, while the mean values for wing length vary from 69.8 in N Morocco to 72.4 on Els Columbrets and in Catalonia, within the range reported from the C Mediterranean (table 1; Spina et al., 1993; Waldenström et al., 2004). Morphometric characteristics of the European Robin vary with geographical region, age and sex, with longer wings found in northern populations, adults and males (Domínguez et al., 2007). Third primary lengths show a significant decreasing trend over time (fig. 6), probably reflecting seasonal changes in the age and sex of migrants; the smallest values are recorded in Morocco. These results agree with the migration patterns documented for this species, with males arriving earlier on breeding grounds than females (Tøttrup & Thorup, 2008), and suggest some degree of differentiation in the populations present in Morocco and NE Spain.

Mean values for fat scores vary between 1.1 on Els Columbrets and 3.6 in N Morocco, while the mean body mass varies from 14.7 to 17.6 at the same sites (table 1). Fat shows a general temporal increase, although the opposite is found in physical condition and mass (fig. 9), the latter probably due to the decrease in size indicated by third primary length. Mean fat is highest in N Morocco, intermediate in Catalonia and the wet Balearics, and lowest in the dry Balearics and, particularly, on Els Columbrets (fig. 9). Physical condition shows a similar pattern, although in this case Catalonia and the dry Balearics have similar values (fig. 7). Higher body mass and better physical condition in birds from the wet Balearics compared to the dry Balearics may reflect the higher proportion of wintering birds and greater habitat suitability in the former site (but also, see below). On the other hand, the fact that birds from the wet Balearics also have higher average body mass and are in better physical condition than in Catalonia could be explained by the need for birds trapped on islands to build up larger energetic reserves in order to cross the Mediterranean.

The mean body mass in birds crossing the C Mediterranean (mean 14.5, n = 2,390; Spina et al., 1993) is similar to that observed on Els Columbrets, but lower than in the Balearics. Birds from N Morocco show similar values to those captured in N Tunisia during spring migration (mean 17.1, n = 19; Waldenström et al., 2004), indicating that overall mean body mass in N Africa is similar to that recorded in S Iberian Peninsula (mean 16.5 in Gibraltar [n = 28; Finlayson, 1981] and 17.3 on L'Illa Grossa [n = 52]), but higher than in Catalonia and on the Balearics. Robins, thus, seem to build up the greatest amounts of energetic reserves in S Spain and coastal NW Africa before moving northwards.

Stopover

The percentage of retraps is highest in Catalonia and the wet Balearics, although the mean stopover length is similar in all areas (too little data from Morocco to be relevant; fig. 5). In all areas with available data, fuel deposition rates tend to be significantly negative (table 2) and birds staying for a few days show significantly lower initial body mass than those not retrapped (fig. 5). These results suggest that these areas do not offer good refuelling opportunities for migrating robins and do not support differences in habitat suitability between wet and dry Balearics. The higher proportion of retraps in Catalonia and the wet Balearics may respond to higher proportions of wintering birds in these areas, although the observed negative refuelling rates may reflect their inability to build up energetic reserves prior to migration.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	1,894	72.4 ± 1.9 (67.0-79.0)	54.5 ± 1.6 (49.5-60.0)	15.9 ± 1.6 (10.5-23.6)	2.3 ± 1.1 (0-6)
Columbrets	446	72.4 ± 2.1 (65.0-78.5)	54.3 ± 1.8 (49.4-60.5)	14.7 ± 1.8 (10.5-20.7)	1.1 ± 1.1 (0-4)
Balearics (dry)	5,966	71.7 ± 1.9 (63.0-79.5)	54.0 ± 1.7 (46.0-61.0)	15.4 ± 1.7 (9.9-24.1)	2.1 ± 1.1 (0-6)
Balearics (wet)	103	71.9 ± 1.8 (68.5-75.5)	54.1 ± 1.4 (51.5-57.5)	16.6 ± 1.7 (13.0-23.7)	2.1 ± 0.9 (0-5)
Chafarinas	0				
N Morocco	8	69.8 ± 1.6 (67.5-72.0)	52.6 ± 1.6 (51.0-55.0)	17.6 ± 0.8 (16.7-18.9)	3.6 ± 0.7 (3-5)
S Morocco	2	71.0 ± 2.8 (69.0-73.0)	52.5 ± 2.1 (51.0-54.0)	15.9 ± 1.2 (15.0-16.7)	2.5 ± 0.7 (2-3)

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	-0.12 ± 0.06 (332)	-0.22 ± 0.18 (30)	-0.25 ± 0.04 (738)	0.01 ± 0.16 (22)		
Retraps >1 day	-0.01 ± 0.04 (242)	-0.11 ± 0.16 (23)	-0.10 ± 0.03 (527)	0.04 ± 0.09 (17)		

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

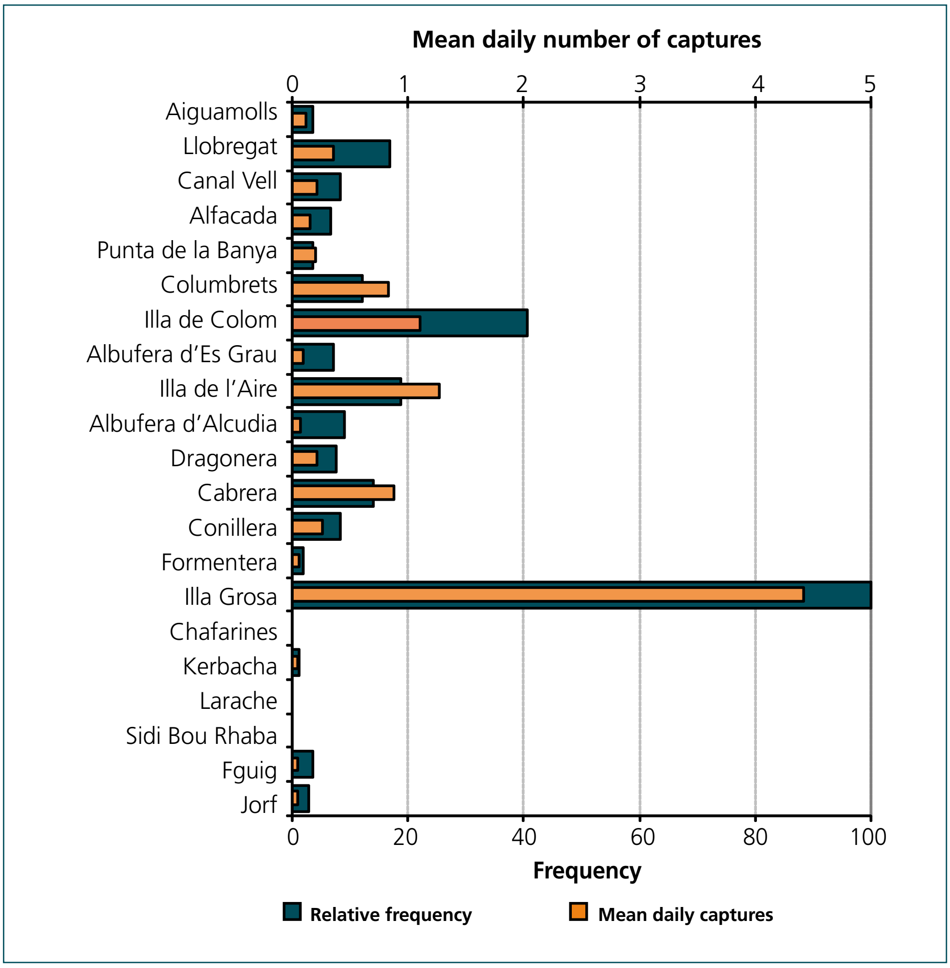


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

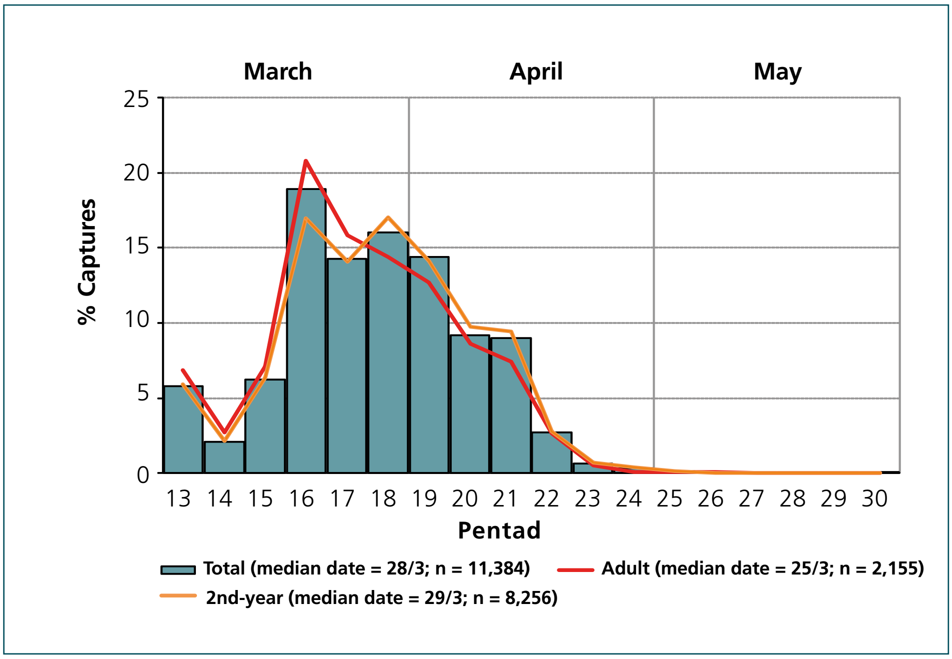


Figure 3. Frequency of captures during the study period.

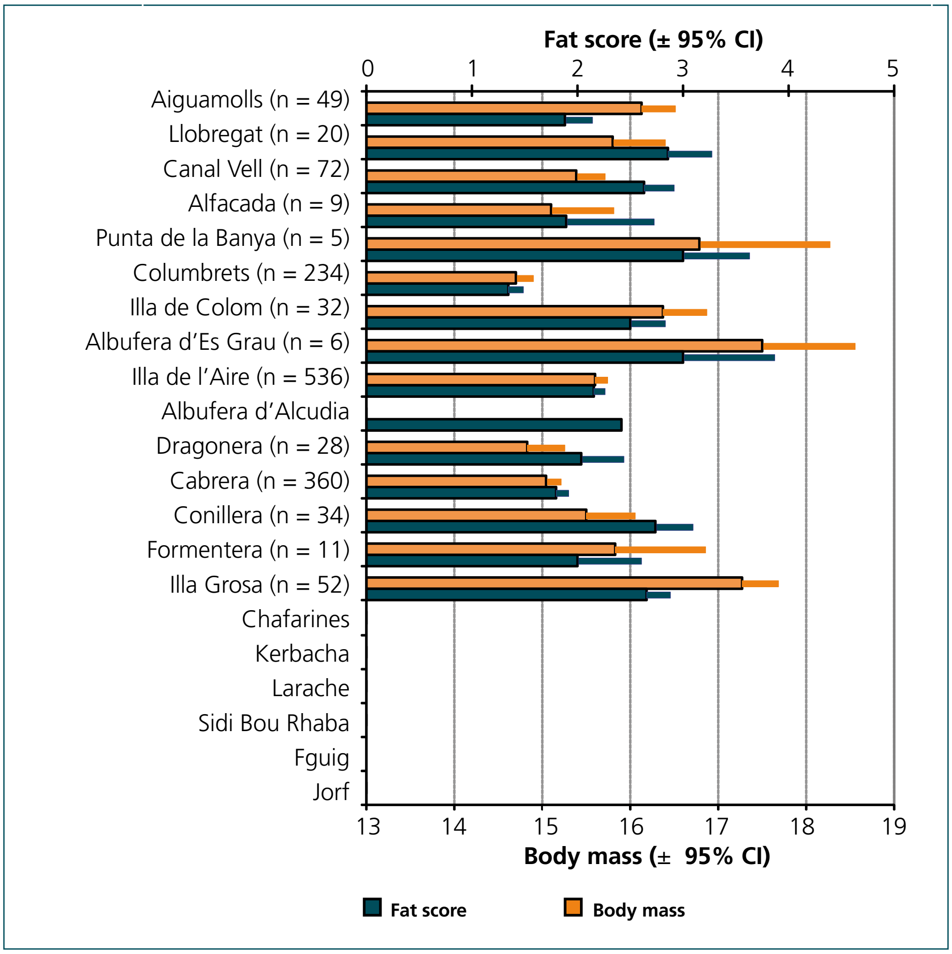


Figure 4. Variation in body mass and fat score according to site during the standard period (16 April to 15 May).

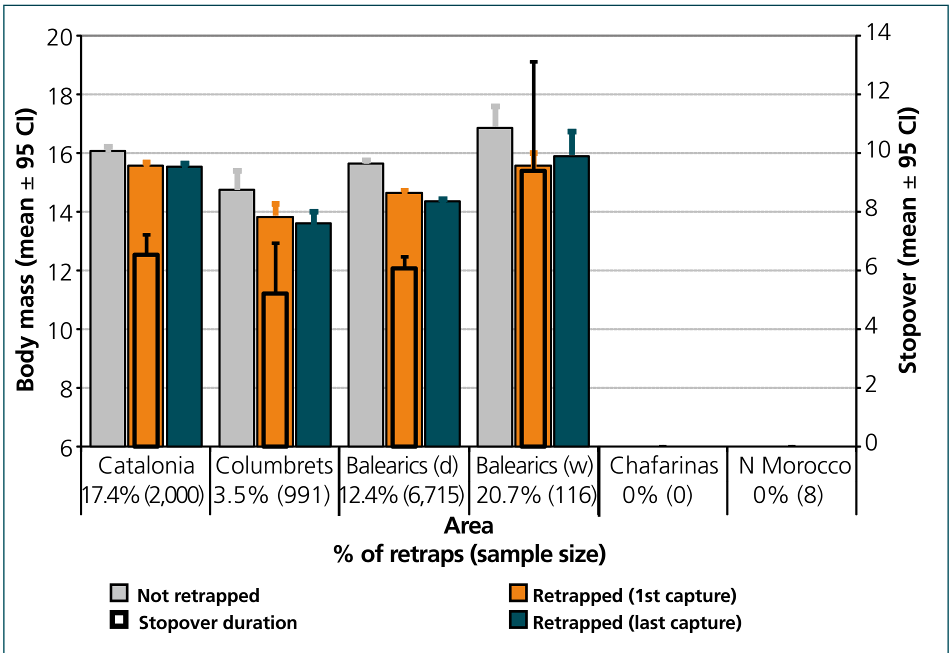


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.

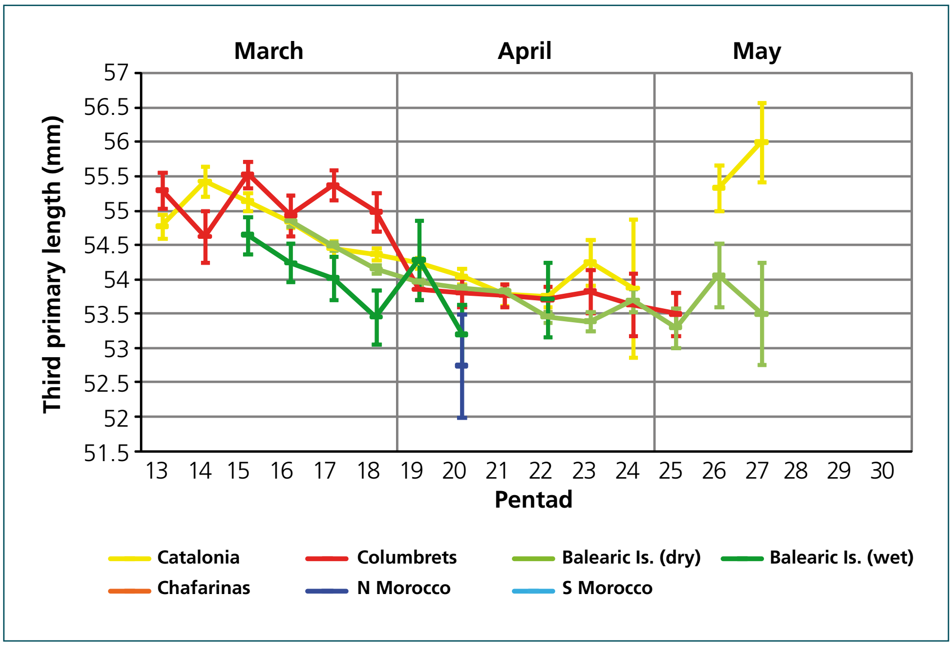


Figure 6. Temporal variation of third primary length according to area.

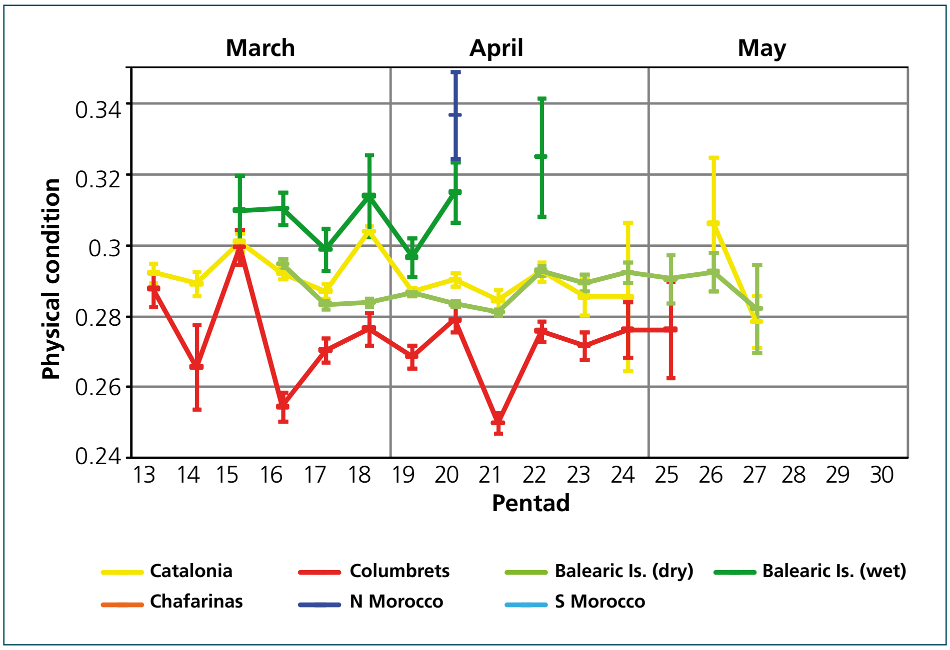


Figure 7. Temporal variation of physical condition according to area.

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

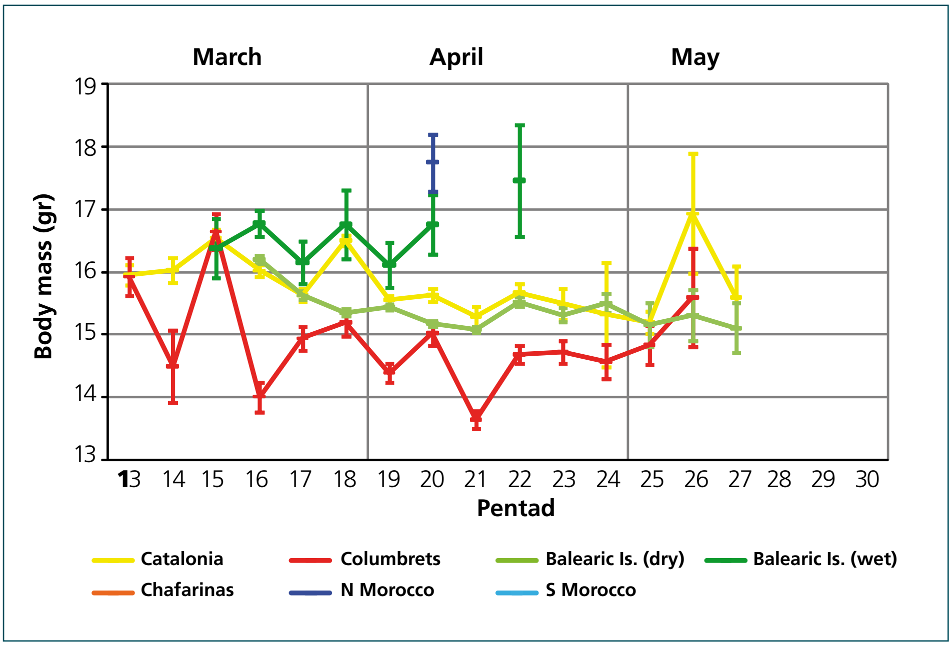
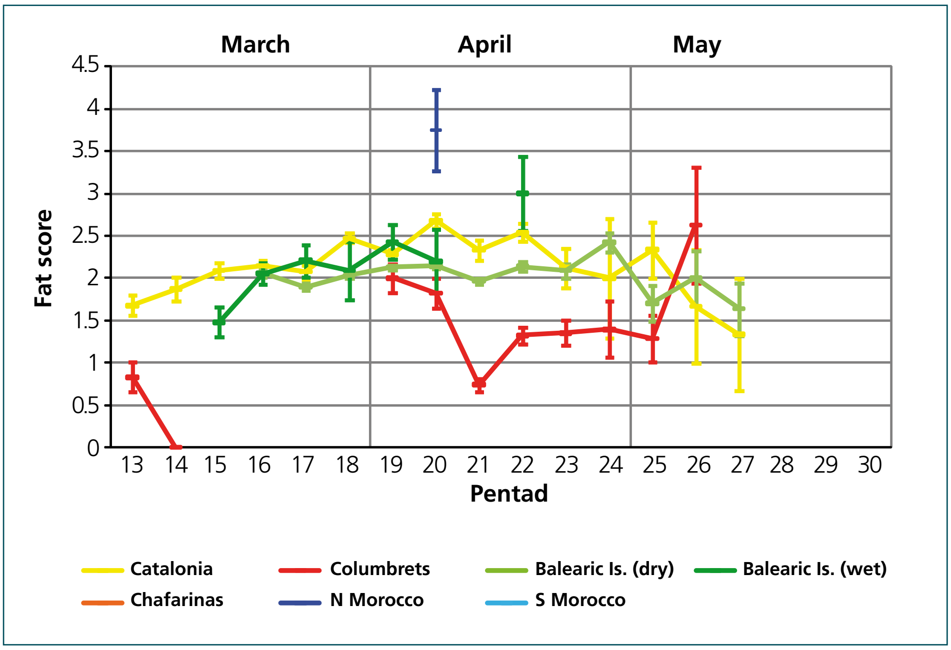


Figure 9. Temporal variation in fat score according to area.



Nightingale

Luscinia megarhynchos

Carles Barriocanal & David Robson

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)

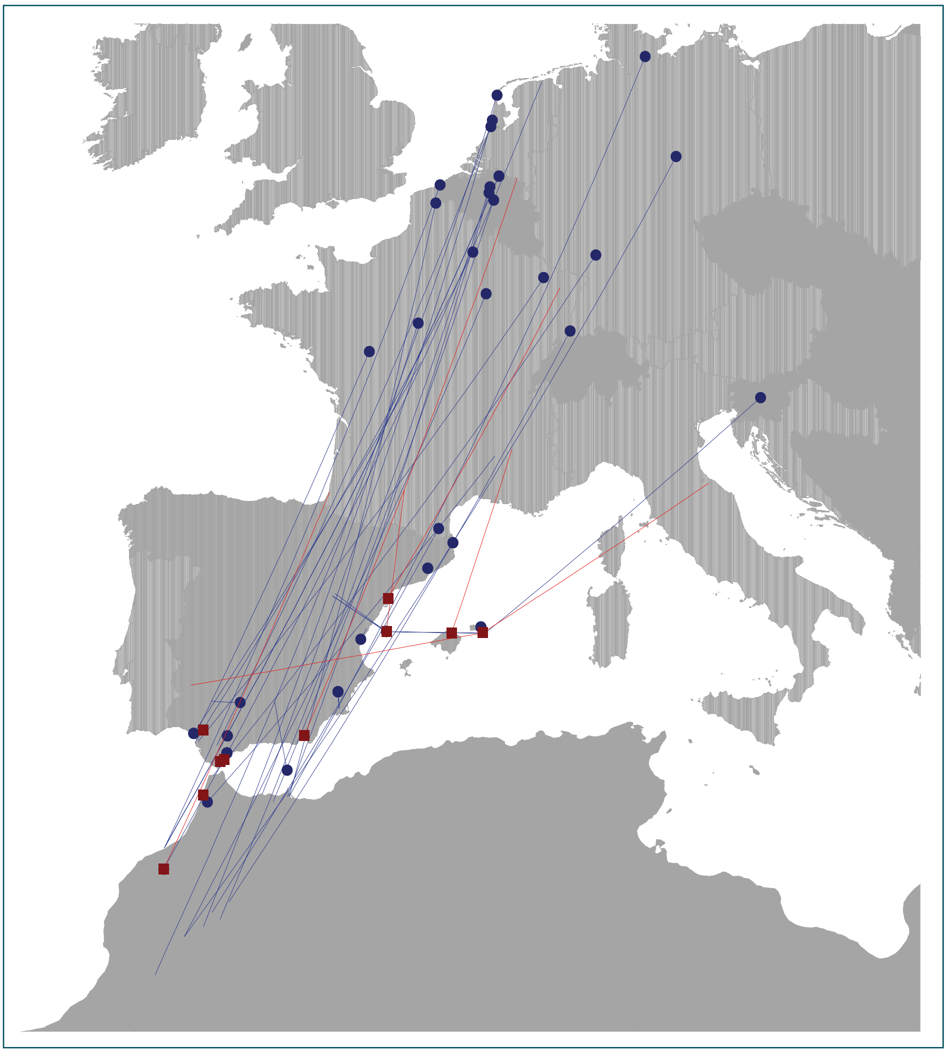


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

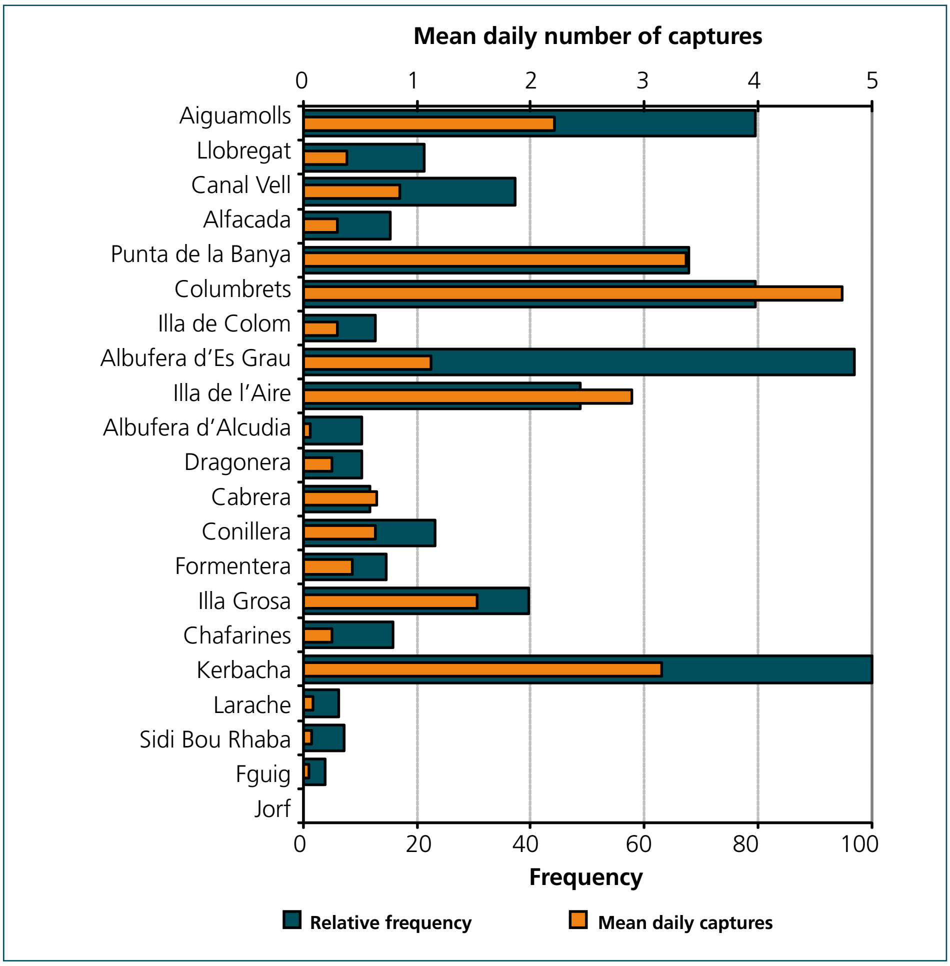


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

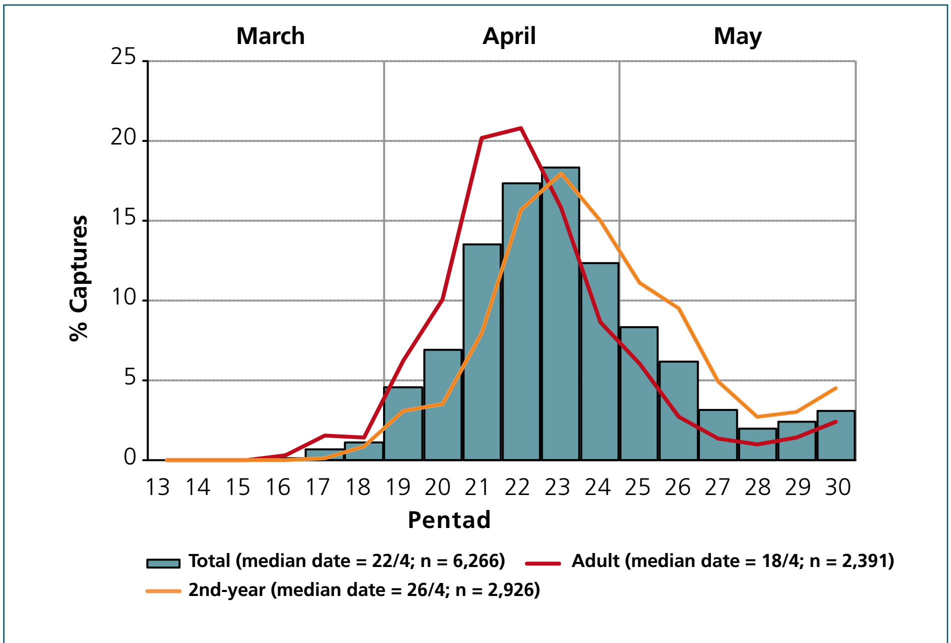


Figure 3. Frequency of captures during the study period.

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

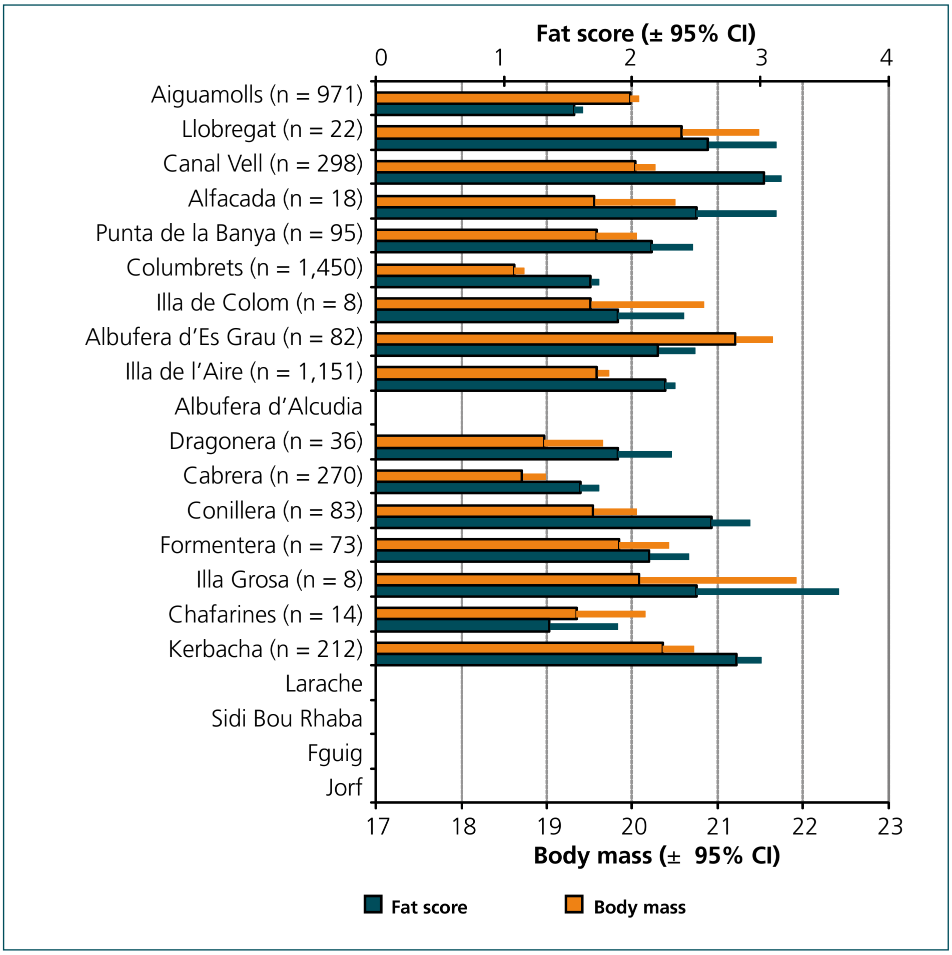
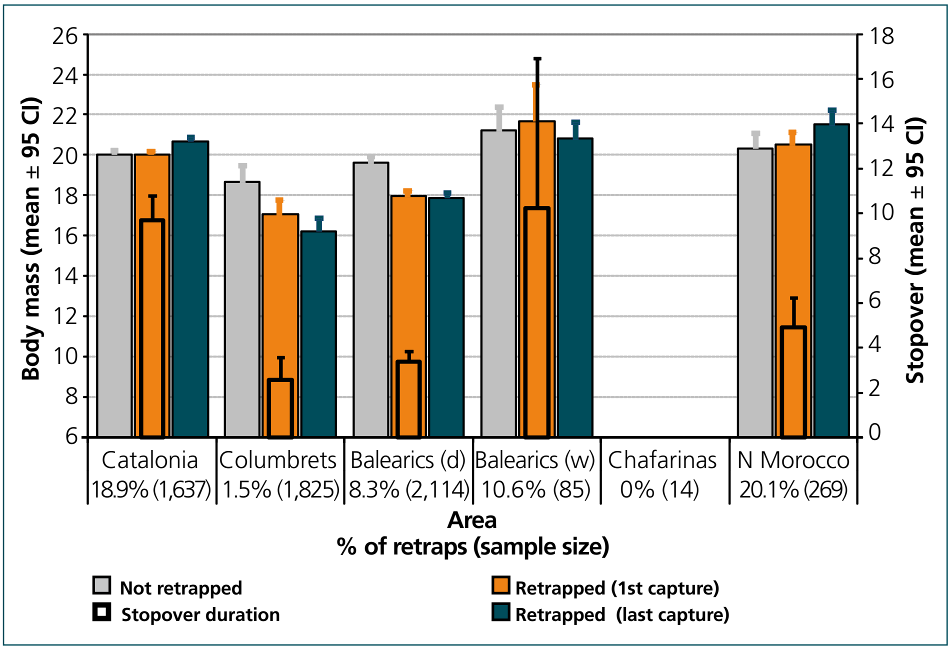


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



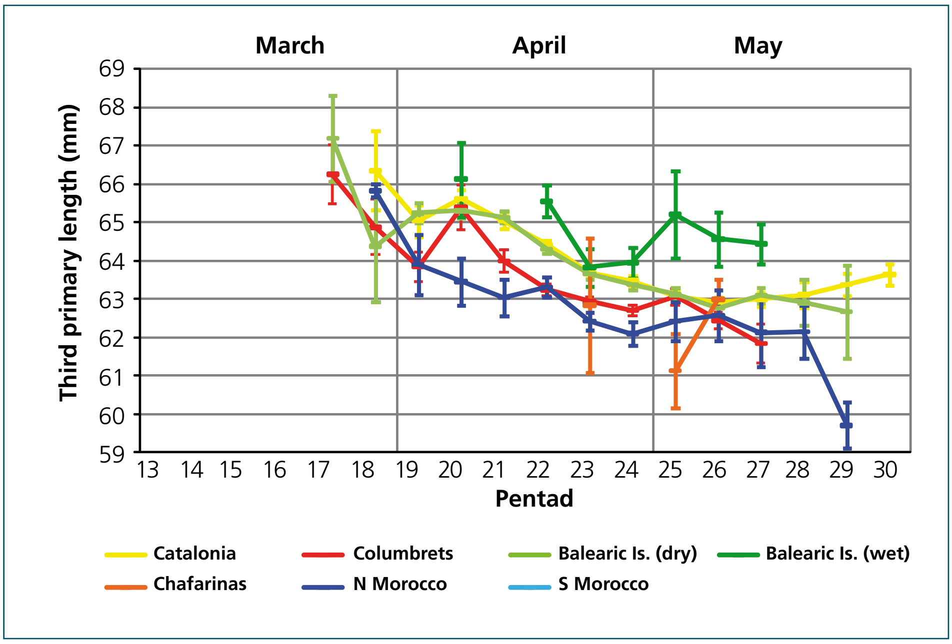


Figure 6. Temporal variation of third primary length according to area.

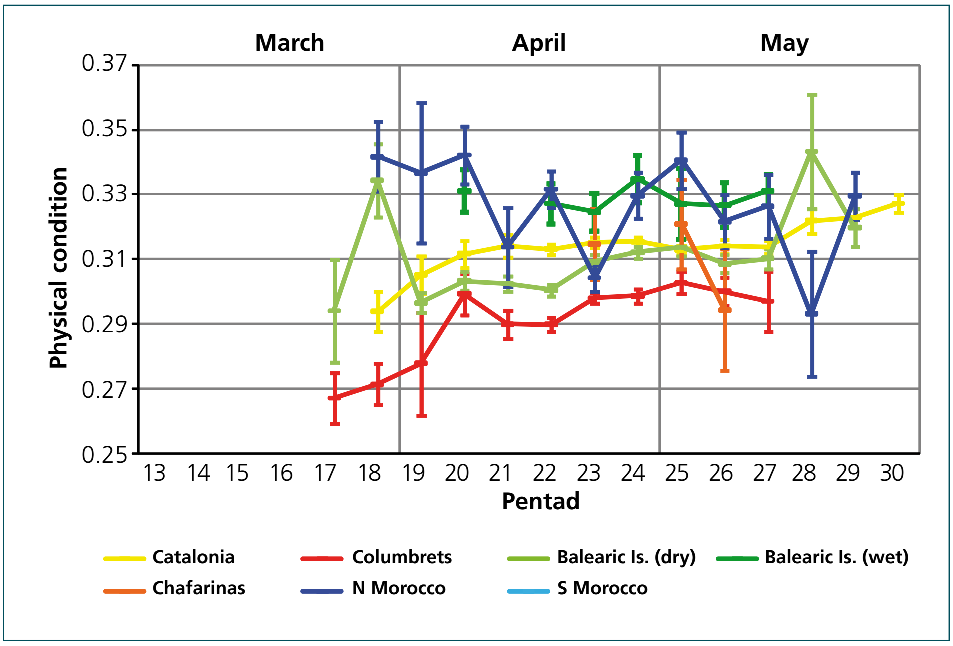


Figure 7. Temporal variation of physical condition according to area.

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

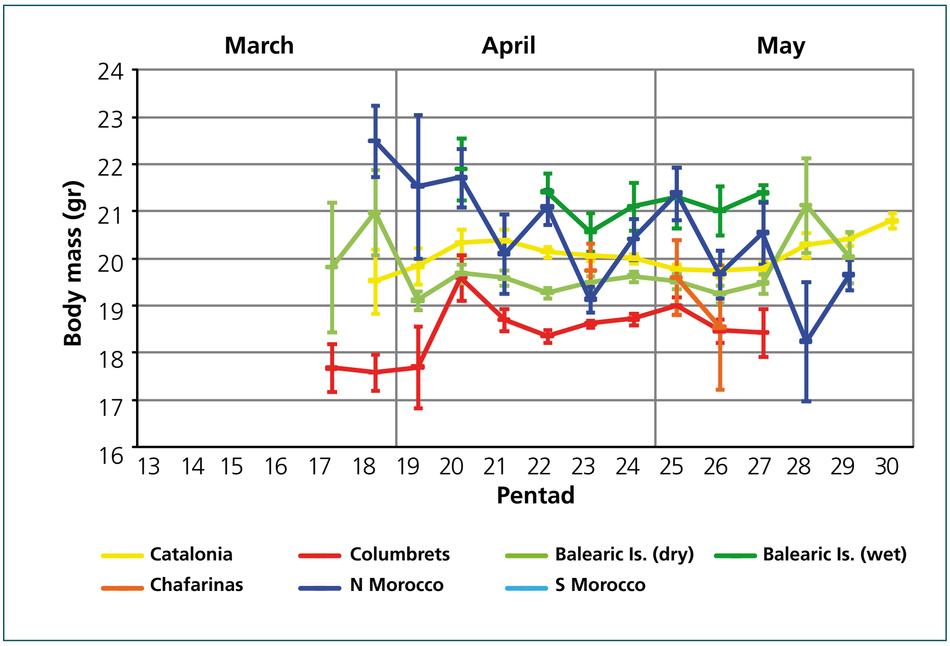
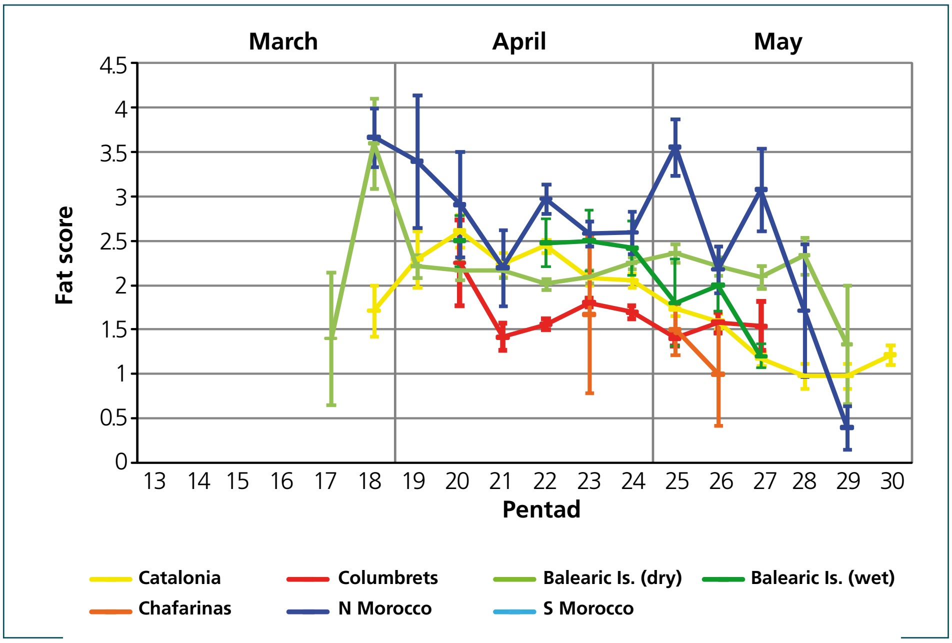


Figure 9. Temporal variation in fat score according to area.



Common Redstart

Phoenicurus phoenicurus

José Amengual

Range

The Common Redstart's breeding range extends throughout much of Europe, and eastwards to central Siberia and Mongolia (Cramp, 1988). It is a long-distance migrant, the vast majority of birds wintering in the Afrotropics; a few birds winter in Arabia or very occasionally north of the Sahara (Moreau, 1972; Cramp, 1988). In W Africa it is largely confined to the Sahel *c.* 10-17ºN, but in E Africa extends further southwards to northern Congo and Uganda (Moreau, 1972; Cramp, 1988; Zwarts et al., 2009). It does not breed at any of the study sites.

Migratory route

This species migrates through the study area on a main SW-NE axis (fig. 1), although some birds seem to move more in a due N or even NW direction (to the British Isles). Other birds move in an almost easterly direction, as exemplified by a bird ringed on Cabrera (Balearics) and recovered 6 days later in Sardinia (Italy). Interestingly, recoveries involving birds trapped in the Balearics/Els Columbrets show a distinctly more due N axis of movement than those of birds migrating through continental Spain and Catalonia (mean direction 16.38ºNNE and *c.* 38ºNE, respectively). This may indicate that those undertaking longer sea-crossings tend to take a more direct due N route and may involve a higher proportion of delayed birds in a hurry (*cf.* Barriocanal & Robson, 2006). In fact, the average date of capture of recoveries from the Balearics/Els Columbrets is significantly later –*c.* 11-17 days– than in Catalonia and rest of Spain. Some birds seem to cross the Mediterranean by very different routes each spring. This is the case of one bird ringed in NE Spain in one year and recovered the following year in Tunisia (980 km south-west), and of another ringed on the Tyrrhenian islands one spring and recovered in NE Spain the following one (1,066 km west).

Spring migration through SW Europe takes place further east than in autumn since recoveries in spring decrease in SW Iberia but increase in NE Spain and France (Zink, 1981; Cramp, 1988; Bueno, 1992; Wernham et al., 2002). This pattern is exemplified by two recoveries of birds captured in the Balearics/Els Columbrets during spring and retrapped distinctly westwards in central Spain and Portugal in autumn (662 and 861 km away, respectively). Recovery data from Italy corroborates this migratory pattern (Pettersson et al.,1990; Spina & Volponi, 2009) and several birds ringed there in spring have been recaptured in the W Mediterranean in autumn.

This species seems to cross the W Mediterranean across a rather broad front, since captures and relative frequencies are particularly high in the Balearics and on Els Columbrets (fig. 2). These insular figures may be misleading due to a high attraction effect since captures at less exposed sites such as the wet Balearics are distinctly lower, and in Catalonia the highest figures correspond to the quasi-island of La Punta de la Banya. However, captures are common on all islands and passage through the area certainly occurs in good numbers. Figures are rather low in Morocco where this species is thought to be more common in autumn than in spring (Cramp, 1988). Information on the use of NW Africa in spring, however, is contradictory, since some authors report the highest number of recoveries in spring (Zink, 1981; Wernham et al., 2002), but others do so in autumn (Zwarts et al., 2009). According to the latter, 80% of recoveries in NW Africa (excluding winter) from the Atlas or areas to the north take place in autumn and the rest in spring (decreasing to 60% when also considering the Sahara desert). In Morocco only 60% of recoveries occur in autumn and 40% in spring (Moroccan Ringing Centre, unpubl. data). Taking into account the overall reduction in numbers in spring due to mortality, this information suggests that the species is probably rather common and widespread in Morocco in both seasons (*cf.* Thévenot et al., 2003), although numbers trapped at specific sites may vary largely.

Phenology

Passage through the area extends mostly from mid-March to late May, and most birds pass in April and the first half of May with a peak during late April (fig. 3). The pattern is very similar in all three major study areas (Catalonia, Balearics and N Morocco) and to that reported elsewhere for the region. Nevertheless, a few birds do still pass through in early June (outside the study period) and from late February or early March (Cramp, 1988; Finlayson, 1992; Telleria et al., 1999; Thévenot et al., 2003; ICO, 2010). The overall phenological pattern in the C Mediterranean is similar to that described here, although the reported median date of passage on Capri (3 May) suggests some delay with respect to the W Mediterranean (Pettersson et al., 1990; Spina et al., 1993). In S and SE Morocco passage can start in February, although it only really gets underway in early March with a peak in first half of April (Smith, 1968; Thévenot et al., 2003; Gargallo et al., unpubl.).

Males migrate distinctly earlier than females (differences in median dates 11 and 12 days in adults and second-year birds, respectively), although adults do so only slightly earlier than second-year birds (2 and 3 days earlier in males and females, respectively). Large temporal gaps in the passage of the sexes have also been reported from Capri (Pettersson et al., 1990) in accordance with the later arrival of females on breeding grounds (Cramp, 1988). Recoveries show that the further north birds are ringed/recovered, the later they pass through the study area, indicating that northern populations tend to migrate later.

Biometry and physical condition

Mean values for third primary lengths range from 60.8 in N Morocco to 62.0 in the wet Balearics (table 1), similar to the means reported from the islands of the C Mediterranean (mean 61.5, n = 556; Spina et al., 1993). Mean values for wing lengths vary from 78.6 in N Morocco to 80.5 in the wet Balearics, similar to the means reported from other parts of W Europe (Cramp, 1998). There is a steady decrease in the length of the third primary during the migration season in accordance with the later passage of shorter-winged females (see above; fig. 6). The apparent increasing trend observed in some areas (N Morocco and the wet Balearics) is due to a small sample size and is not significant. The lengths of the third primary on Els Columbrets and in the dry Balearics are significantly shorter than in Catalonia.

Fat reserves are clearly lowest in S Morocco and on Els Columbrets and highest in N Morocco, the wet Balearics and Catalonia (fig. 9, table 1). Birds trapped in S Morocco are found to be in the poorest physical condition. Birds trapped on Els Columbrets have distinctly lower average fat reserves than in the dry Balearics and Catalonia, while birds have the best physical condition in the wet Balearics and N Morocco (fig. 7). Fat and physical condition do not show any clear overall temporal trend. Fat decreases significantly on Els Columbrets but increases in Catalonia (fig. 9) and physical condition increases on Els Columbrets and in the dry Balearics (fig. 7). Mean body mass varies from 12.9 in S Morocco to 15.2 in the wet Balearics with no clear overall temporal trend observed (fig. 9). It increases significantly with time in dry Balearics, but remains fairly constant in Catalonia and on Els Columbrets. Averages are distinctly higher in the wet Balearics and N Morocco. In Catalonia, body mass is only marginally higher than in the dry Balearics, but in both areas is clearly greater than on Els Columbrets. Body mass on Els Columbrets and in the dry Balearics is slightly higher than on the Tyrrhenian islands (mean 13.2, n = 557; Spina et al., 1993). The average from N Morocco is very similar to that given for N Tunisia (mean 14.9, n = 39; Waldenström et al., 2004), and in S Morocco is nearly identical to that reported in larger datasets in different years at the nearby sites of Defilia (13.1, n = 110; Ash 1969) and Merzouga (12.9, n = 181; Gargallo et al., unpubl.), suggesting that our figures are very representative of the area as a whole.

According to our data, birds trapped in N Morocco are *c.* 15% heavier than in the south of the country, indicating that they are able to fatten up after crossing the Sahara. Although birds have good energetic reserves in N Morocco, those trapped at continental and insular stopover sites are not in markedly poorer condition (only somewhat so at more isolated and distant islands such as Els Columbrets). Reported spring average mass at Gibraltar (14.0, n = 24; Finlayson, 1981) is very similar to that of Catalonia, but is *c.* 11% higher in Holland and Denmark (mean 15.7, n = 250; Cramp, 1988), suggesting that further north in continental Europe birds can regain reserves and undertake net mass gains.

Stopover

The percentage of retraps and mean stopover length is very low in all areas (fig. 5, table 2). Birds staying on islands are in poorer condition at first capture than those not trapped again, indicating some reluctance for birds in good condition to stay at these sites. On Els Columbrets birds show significant negative fuel deposition rates (when using all the dataset), but in the dry Balearics the tendency is positive (although only significant when considering retraps of more than one day). In continental areas fuel deposition rates are positive (in Catalonia when considering more than one-day retraps), but only significantly so in the very limited sample from N Morocco. As suggested above, these results indicate that birds are able to regain some mass even at apparently less suitable sites (*e.g.* the dry Balearics), probably thanks to their ability to feed efficiently in open terrain (Cramp, 1988). Data from N Morocco also reveals the importance of this area for refuelling, although 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	1,156	79.8 ± 2.1 (73.0-86.0)	61.5 ± 1.9 (54.0-68.0)	14.2 ± 1.3 (6.6-18.8)	2.4 ± 1.1 (0-7)
Columbrets	1,412	79.6 ± 2.3 (73.0-88.0)	61.0 ± 1.9 (54.0-67.0)	13.6 ± 1.6 (6.4-22.2)	1.5 ± 1.1 (0-6)
Balearics (dry)	5,789	79.2 ± 2.1 (73.0-88.0)	61.0 ± 2.0 (54.0-68.0)	14.1 ± 1.5 (7.1-20.9)	2.1 ± 1.1 (0-7)
Balearics (wet)	16	80.5 ± 1.8 (77.5-83.5)	62.0 ± 1.8 (58.0-65.5)	15.2 ± 1.5 (12.8-18.7)	2.9 ± 1.1 (1-5)
Chafarinas	11		61.1 ± 2.6 (59.0-67.0)	14.7 ± 2.7 (11.0-19.5)	1.9 ± 1.3 (0-4)
N Morocco	33	78.6 ± 2.2 (73.0-85.0)	60.8 ± 1.9 (56.5-65.0)	14.8 ± 1.9 (11.5-21.2)	2.4 ± 1.4 (0-6)
S Morocco	21	79.8 ± 2.3 (75.5-84.5)	62.0 ± 2.0 (58.5-66.0)	12.9 ± 1.2 (11.3-16.0)	0.9 ± 0.8 (0-2)

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	-0.10 ± 0.14 (85)	-0.34 ± 0.26 (27)	0.03 ± 0.06 (301)			0.55 ± 0.10 (2)
Retraps >1 day	0.11 ± 0.15 (46)	-0.02 ± 0.18 (16)	0.12 ± 0.06 (210)			

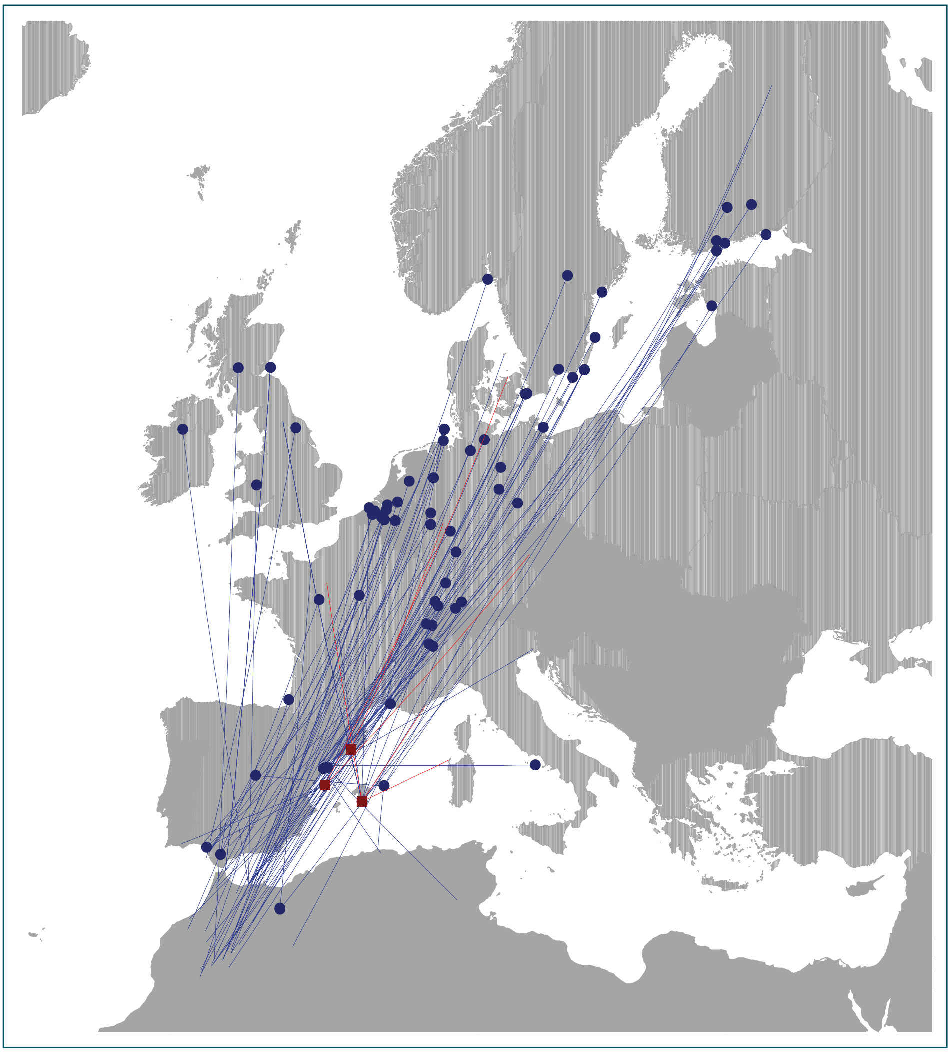


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

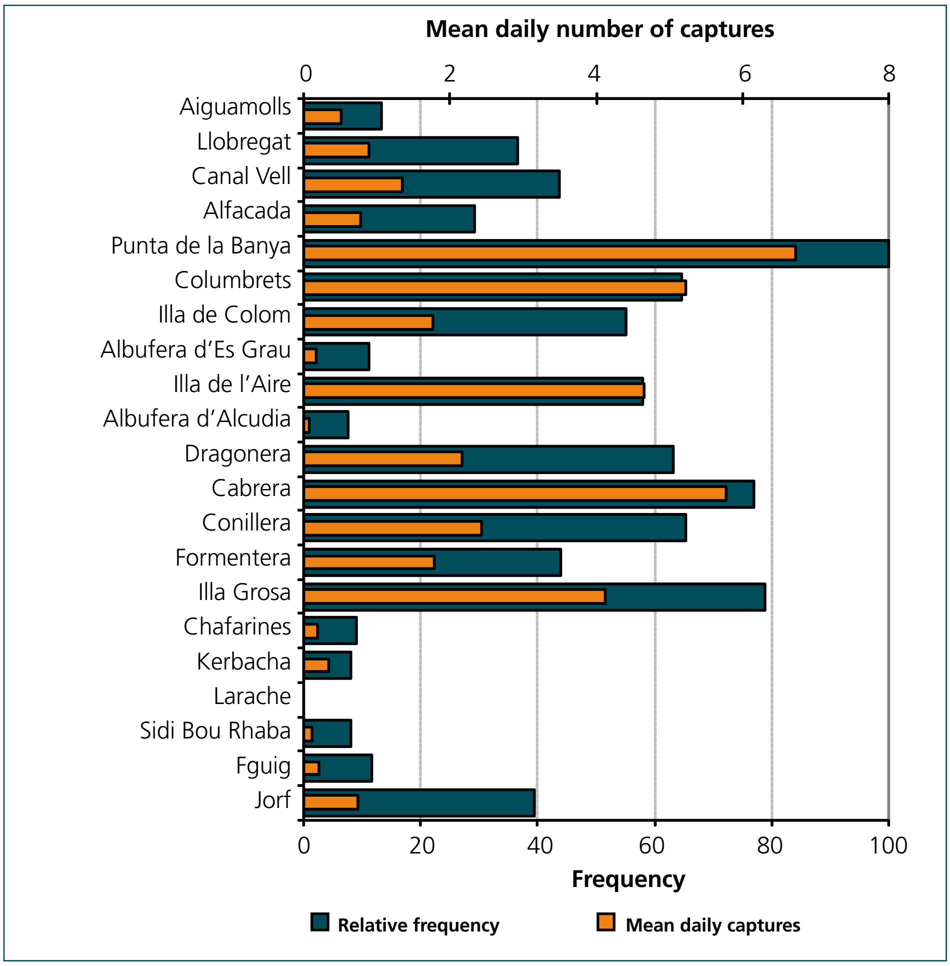


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

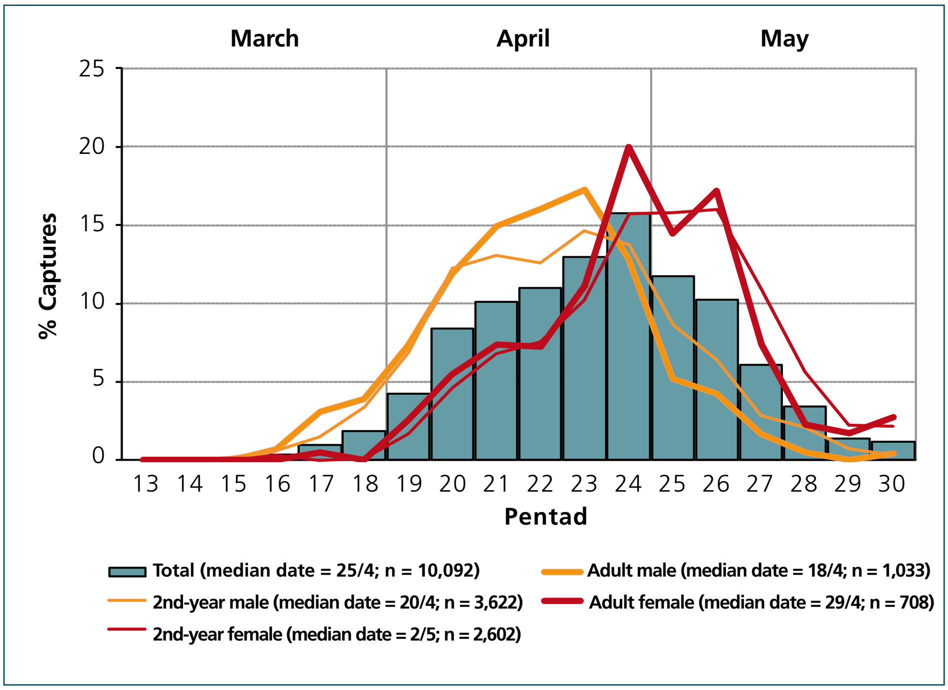


Figure 3. Frequency of captures during the study period.

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

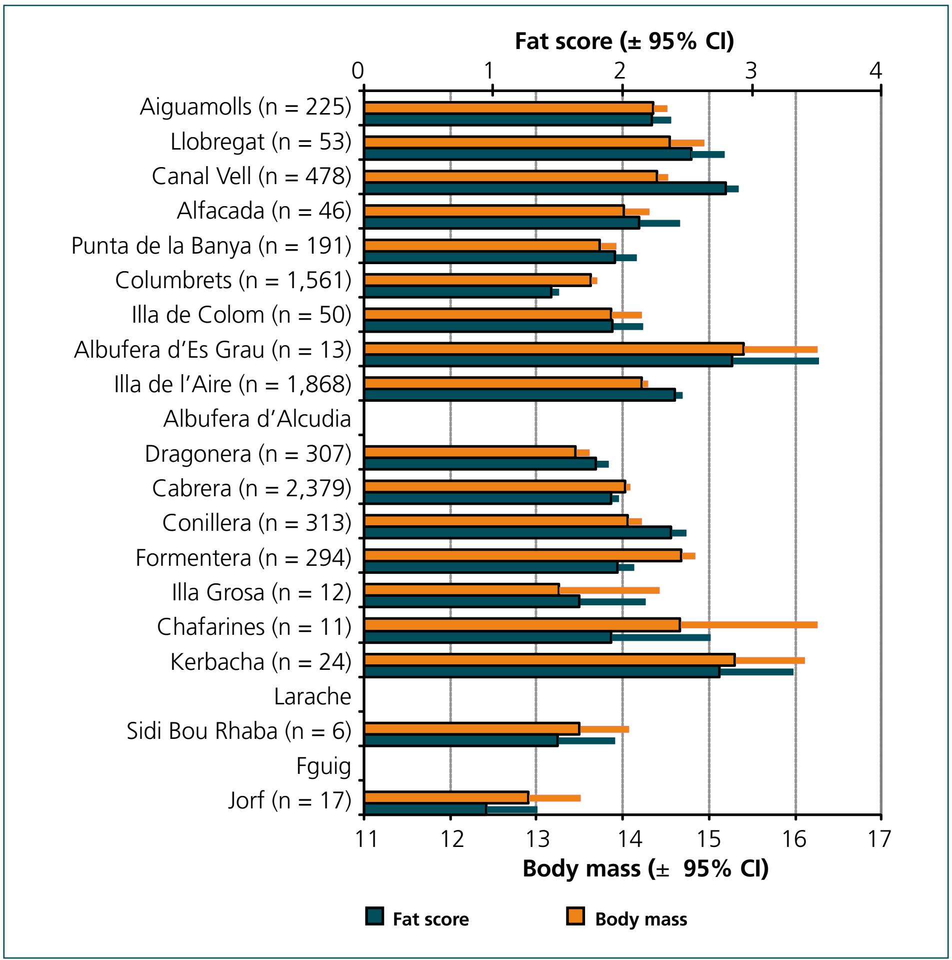
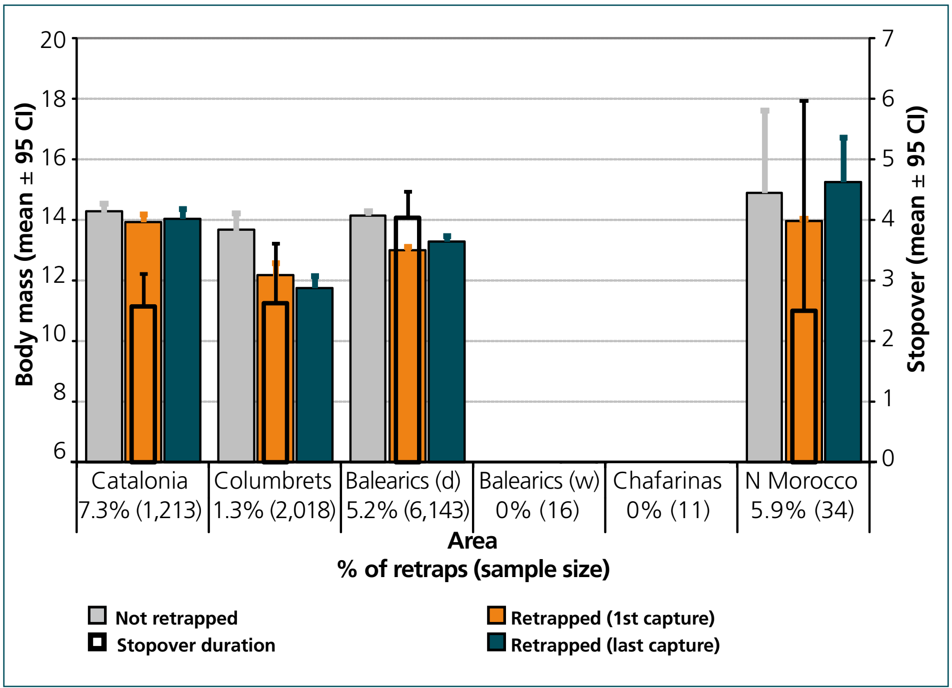


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



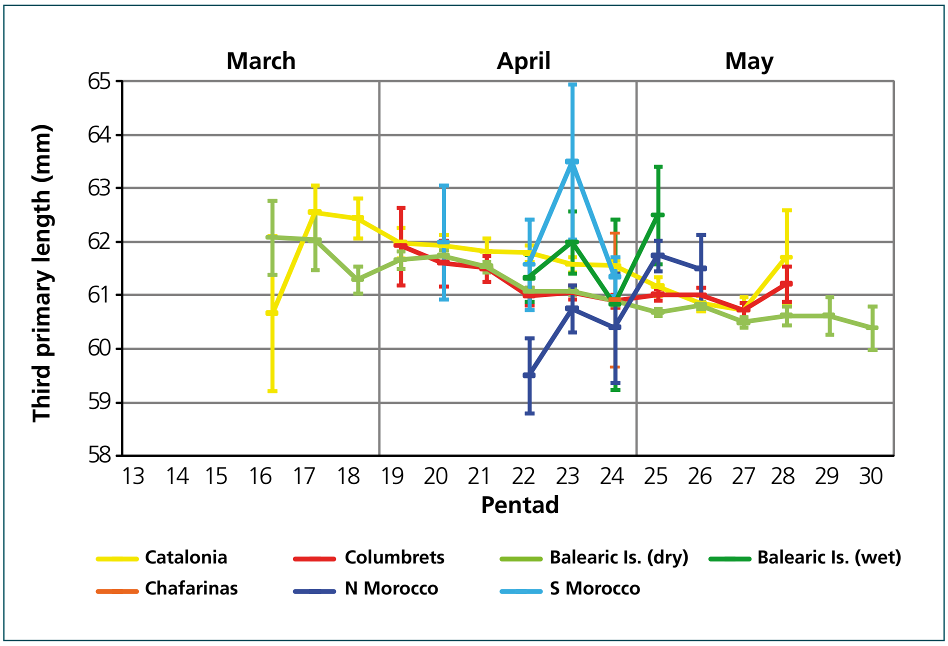


Figure 6. Temporal variation of third primary length according to area.

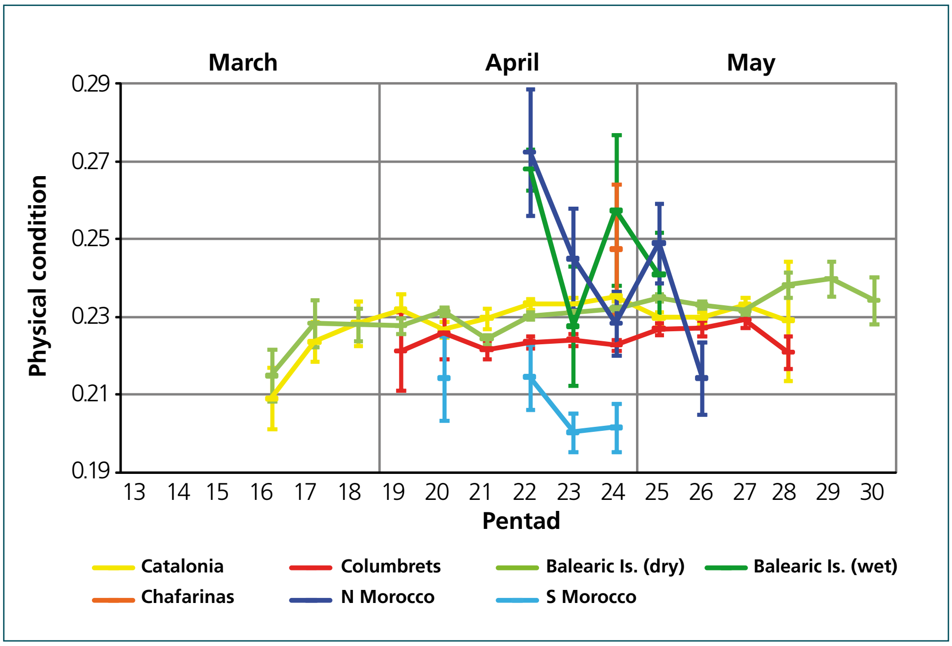


Figure 7. Temporal variation of physical condition according to area.

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

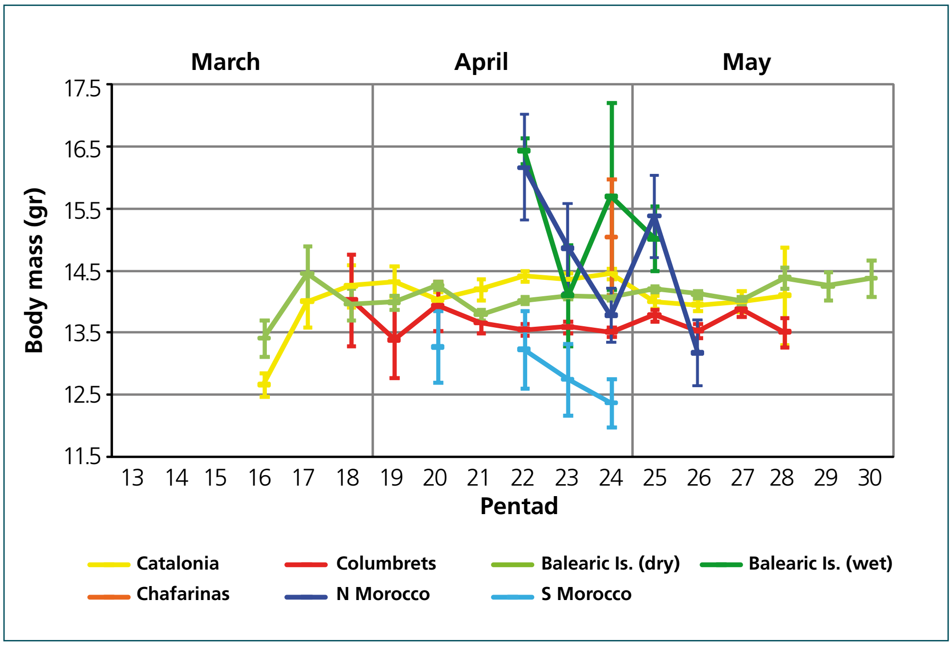
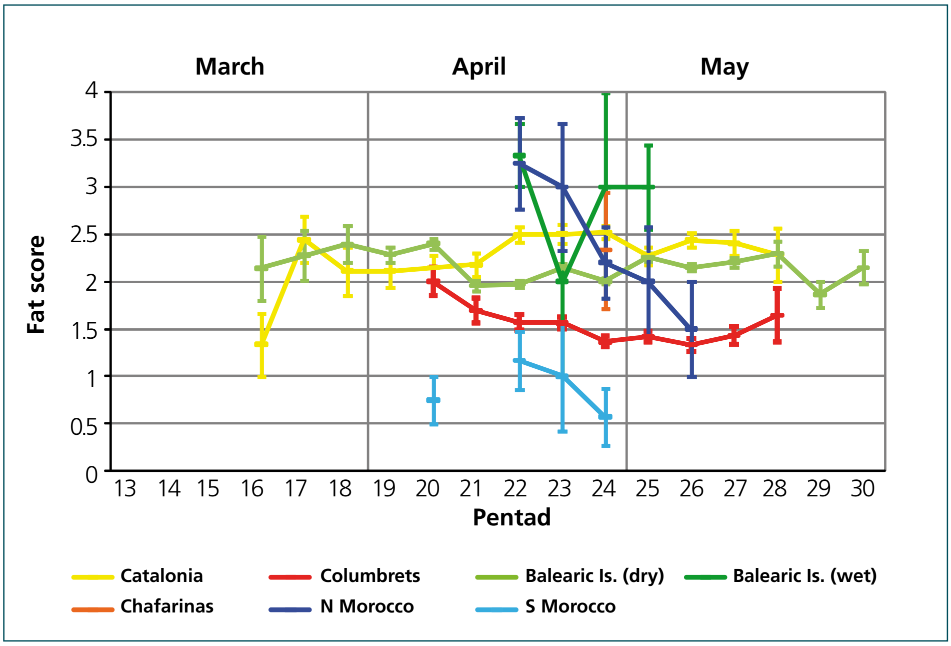


Figure 9. Temporal variation in fat score according to area.



Whinchat

Saxicola rubetra

Eduard Amengual

Range

The Whinchat breeds throughout most of C and N Europe east to W Siberia and NW Iran, but is scarce in the Mediterranean region, where is only patchily distributed (Cramp, 1988). Essentially, it is a long-distance migrant that winters in tropical Africa from Senegal to Uganda in a relatively wide belt just south of the Sahara, as well as in smaller numbers in E Africa south to Zambia and Tanzania. It is a rare winter visitor north of the Sahara and to parts of Arabia and Iraq (Snow & Perrins, 1998; Del Hoyo et al., 2005). It does not breed at any of the study sites.

Migratory route

Recoveries show a main SW-NE migratory direction, except for those from Britain, which largely move along a S-N axis (fig. 1); the opposite pattern to that found in autumn (Zink, 1981; Cramp, 1988; Wernham et al., 2002). A bird ringed on Cabrera in spring and recovered in autumn in N Morocco, 824 km to the WSW, shows that birds return along a more esterly route in spring, a pattern followed by many other species (Spina & Volponi, 2009). Another interesting recovery is of a bird ringed on Els Columbrets in spring and recovered three years later in June in NE Algeria, thereby revealing flexibility in the migratory routes taken.

In accordance with the more eastern route followed in spring, the species is much commoner in Mediterranean Spain and the Balearics in spring than in autumn; in the latter season birds pass mostly through C and W Iberia (Telleria et al., 1999; ICO, 2010). Capture data shows that birds are common in Catalonia and in the Balearics/Els Columbrets, suggesting that migration through this area occurs across a broad front, and that birds do not hesitate to cross large stretches of sea (fig. 2). The proof of this is the exceptionally high number of captures on Cabrera, the site with by far the highest capture rate (c. 55% of the whole sample of this species is from this island). The open fields that characterise this site and its relatively large size probably offer the best stopover conditions for this species. It is also very common on the islands of the C Mediterranean (Pettersson et al., 1990; Spina et al., 1993). Few captures are made in N Morocco, probably due to a lack of the preferred habitat at the specific study sites since the Whinchat is much commoner there in spring than in autumn (Zink, 1981; Cramp, 1988; Thévenot et al., 2003).

Phenology

Passage takes place from early April (rarely late March) through to late May, although most birds migrate through the area between mid-April and mid-May (fig. 3). The phenology in Catalonia and the Balearics/Els Columbrets is similar (data from N Morocco is too scarce to be used), although a few more birds tend to appear during the second half of May on the islands. The overall pattern is similar to that already reported for the area, although a few birds are still on passage in early June and occasionally in late February in N Morocco (Finlayson, 1992; Telleria et al., 1999; Thévenot et al., 2003). In the C Mediterranean, migration possibly takes place slightly later, since the median date of passage on Capri occurs 6 days later than in our study area (Pettersson et al., 1990), although the overall phenological pattern is essentially similar (Spina et al., 1993). In S Morocco, some birds appear in early February, but the main passage period falls between April and early May (Thévenot et al., 2003).

Males pass clearly earlier than females (differences in median dates 11 and 10 days in adults and second-year birds, respectively), although adults are only slightly earlier than second-year birds (4 and 2 days earlier in males and females, respectively; fig. 3). The earlier passage of males is also documented in the C and E Mediterranean (Petterson et al., 1990; Morgan & Shirihai, 1997; Messineo et al., 2001), although reported differences on Capri are less marked than in this region (medians differing by three days for both adults and second-year birds; Petterson et al., 1990). Age-related differences detailed on Capri by Petterson et al. (1990) are of a similar magnitude to those reported here (although the medians differ by just one day in both sexes).

Biometry and physical condition

Mean values for third primary lengths range from 56.8 in Las Chafarinas to 57.7 in Catalonia, the latter average being significantly higher than on Els Columbrets and in the dry Balearics (table 1). Overall, birds trapped in the W Mediterranean are slightly smaller than those reported from the C Mediterranean (mean 57.7, n = 15,280; Messineo et al., 2001), perhaps due to more northern European birds migrating through Italy (*cf.* Spina & Volponi, 2009). Third primary lengths show a tendency to decrease with time (fig. 6), in a similar way to that previously found in the C Mediterranean (Pettersson et al., 1990; Spina et al., 1993), a fact undoubtedly due to differential migration between sexes and age-classes described above (the later migrating females and second-year birds having shorter wings).

Mean fat scores in most areas are fairly low, ranging from 0.7 in Las Chafarines to 3.6 in N Morocco, showing, like physical condition, an overall increase during the migratory period (fig. 9). The overall mean (2.6) is only slightly higher than that reported from the C Mediterranean (mean 2.1, n = 15,077; Messineo et al., 2001). Averages are similarly lower in S Morocco and on Els Columbrets and

Las Chafarinas, significantly so when compared with the other areas. Higher fat loads later in the season may reflect the fact that later arriving birds (more females) are under less energetic stress (having less need to migrate faster) or the improving conditions they encounter as the season progress. Birds captured in S Morocco have the worst physical condition, significantly lower than in N Morocco, Catalonia and in the dry Balearics (table 1, fig. 7).

No temporal trend is obvious in body mass, which remains rather constant throughout the migration period. Mean values vary from 17.6 in N Morocco to 13.8 in S Morocco and Las Chafarinas. Averages are similarly lower in S Morocco and on Els Columbrets and Las Chafarinas, significantly so when compared to N Morocco, Catalonia and the dry Balearics. Mean body masses in S Britain and Wales (16.6, n = 72; Cramp, 1988) are only slightly higher than in Catalonia, while those reported from Gibraltar (16.0, n = 10; Finlayson, 1981) are similar to Catalonia and Balearics. Birds trapped in the Balearics show, however, a rather higher body mass than those from the C Mediterranean islands (mean 14.7, n = 15,396; Messineo et al., 2001), the latter being closer to figures for Els Columbrets. The average in N Morocco is somewhat higher than that reported from a similarly limited sample from N Tunisia (mean 16.7, n = 5; Waldenström et al., 2004). In S Morocco figures are close to those obtained at the nearby sites of Jorf (14.1, n =15; Maggini & Bairlein, 2011) and Merzouga (14.2, n = 6; Gargallo et al., unpubl.), suggesting that figures are representative of the area. These figures are also similar to those from Eilat in the E Mediterranean on the northern edge of the desert (13.8, n = 80; Morgan & Shirihai, 1997).

Birds trapped in N Morocco are *c.* 24-28% heavier than in the south of the country. Although data from N Morocco is scarce, data from N Tunisia (likewise somewhat limited) also show a distinctly higher average (18-21% in this case), suggesting that the difference between northern coastal sites and those located just north of the Sahara are important and that birds fatten up considerably in NW Africa. Since body mass is similar from S Iberia up to Britain, it would seem that this species moves though the continent using short flight bouts and does not involve long stopovers or great changes in mass. Only on more isolated and distant islands (from the African coast) such as Els Columbrets do birds show distinctly lower body mass than in N Morocco (*c.* 15%).

Stopover

The percentage of retraps and mean stopover length is very low in all areas, indicating that the turnover of birds is very high (table 2, fig. 5). Birds remaining in the dry Balearics are in poorer condition at first capture than those not trapped again, indicating some reluctance in birds in better condition to stay at these sites. A similar but non-significant pattern is observed on Els Columbrets: birds on these islands have significant negative fuel deposition rates (when using all dataset), unlike in the dry Balearics where the tendency is positive (but not significant). In Catalonia the fuel deposition rate is also positive (excluding one-day retraps), but likewise not significant. These results indicate that birds stopping at the more isolated and distant sites (Els Columbrets) are not only those in poorest condition, but also those that benefit least from their stays (although the sample size is extremely low). The sample size from N Morocco is too small to throw light on the situation in this area.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	336	76.2 ± 2.0 (70.0-82.5)	57.7 ± 1.8 (52.0-62.5)	16.1 ± 1.4 (11.9-20.7)	2.7 ± 1.2 (0-5)
Columbrets	103	76.4 ± 2.2 (70.5-81.0)	56.9 ± 2.0 (50.5-61.0)	15.1 ± 2.1 (10.5-21.1)	1.3 ± 1.3 (0-7)
Balearics (dry)	1,726	75.6 ± 2.2 (70.0-82.0)	57.0 ± 2.0 (50.5-62.5)	16.0 ± 2.0 (9.9-24.8)	2.5 ± 1.3 (0-7)
Balearics (wet)	12	76.5 ± 2.1 (73.0-80.0)	57.3 ± 1.4 (55.0-59.0)	16.3 ± 1.8 (14.7-19.8)	3.3 ± 1.1 (2-5)
Chafarinas	9		56.8 ± 1.5 (55.0-59.0)	13.8 ± 1.0 (12.1-15.7)	0.7 ± 0.7 (0-2)
N Morocco	5	75.1 ± 1.0 (74.0-76.0)	56.9 ± 1.1 (55.0-58.0)	17.6 ± 3.4 (13.8-22.8)	3.6 ± 1.7 (1-5)
S Morocco	17	76.4 ± 2.3 (71.5-81.0)	57.4 ± 1.4 (54.5-60.0)	13.8 ± 1.5 (11.4-17.0)	1.6 ± 1.0 (1-5)

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	-0.10 ± 0.55 (10)	-1.10 ± 0.34 (3)	0.10 ± 0.27 (41)			
Retraps >1 day	0.45 ± 0.64 (5)		0.08 ± 0.19 (23)			

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

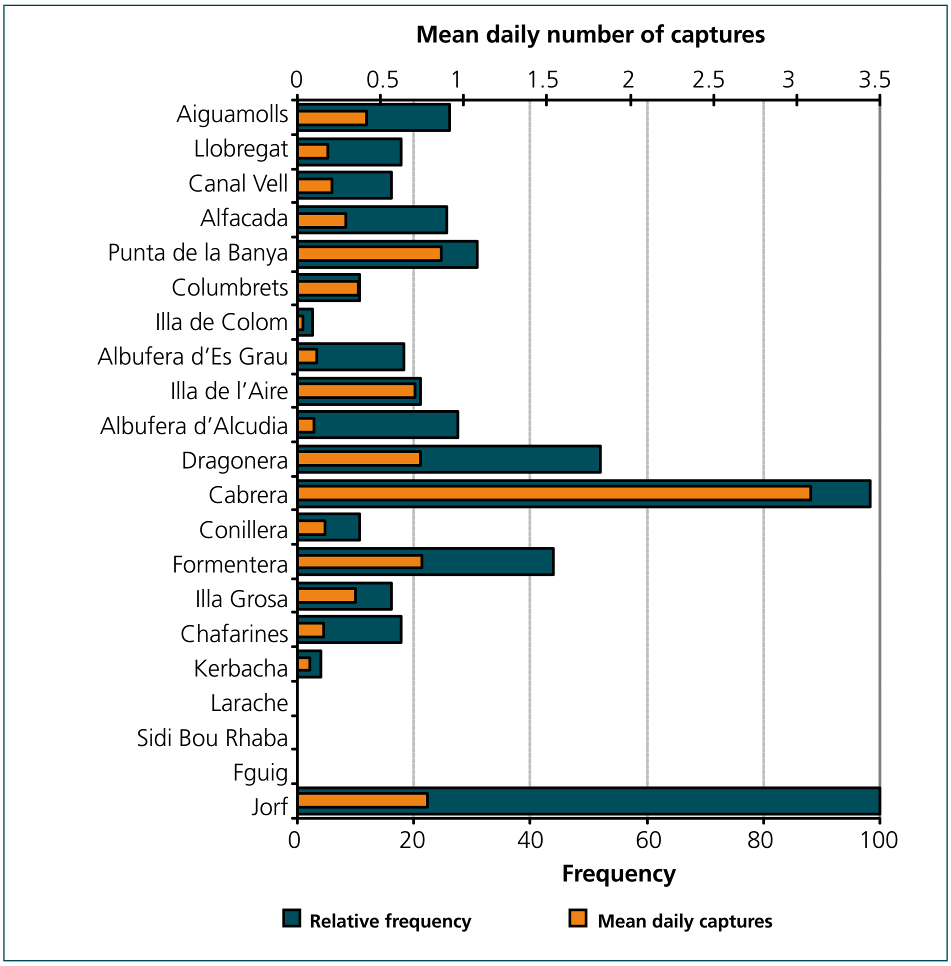


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

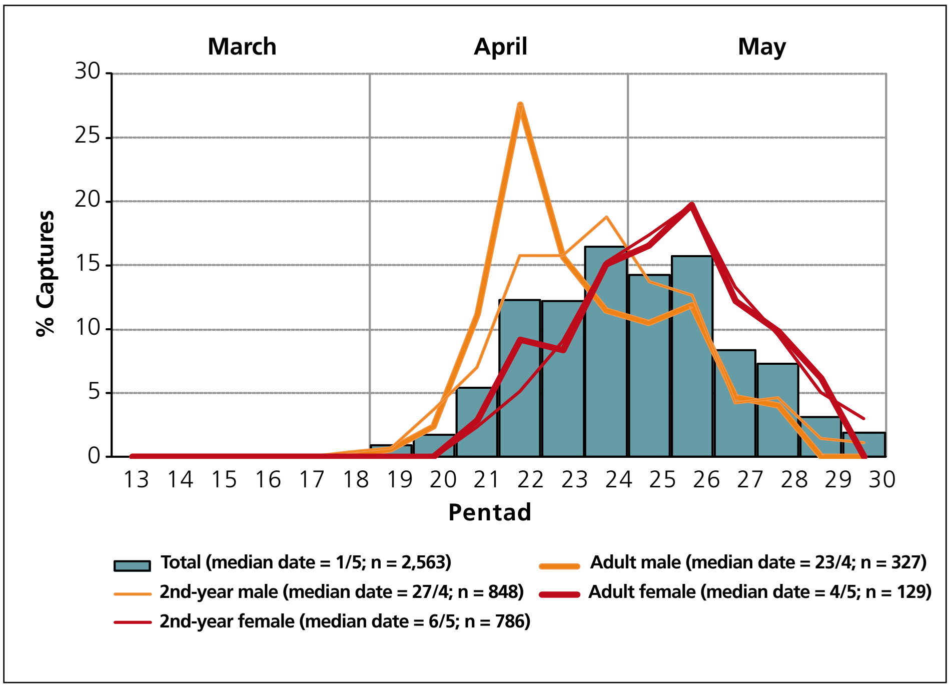


Figure 3. Frequency of captures during the study period.

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

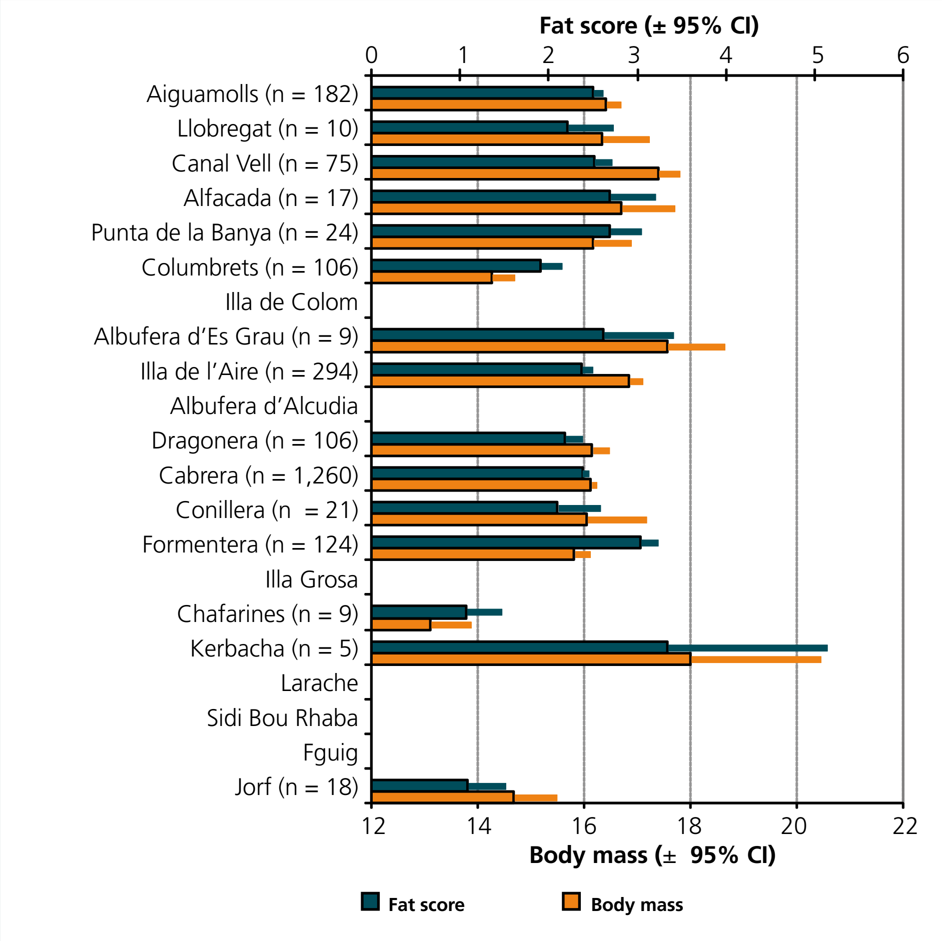
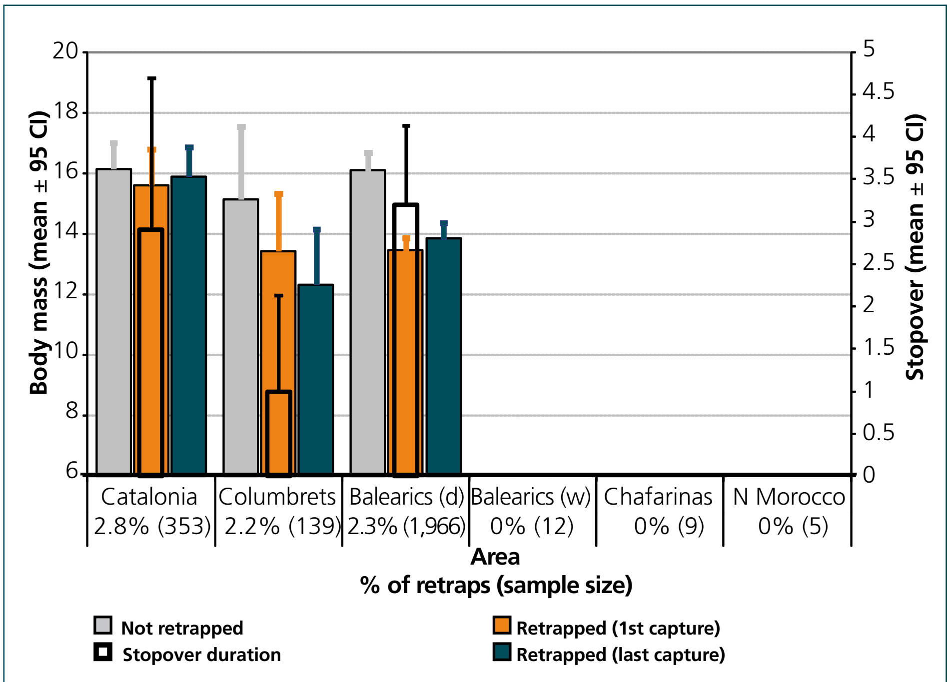


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



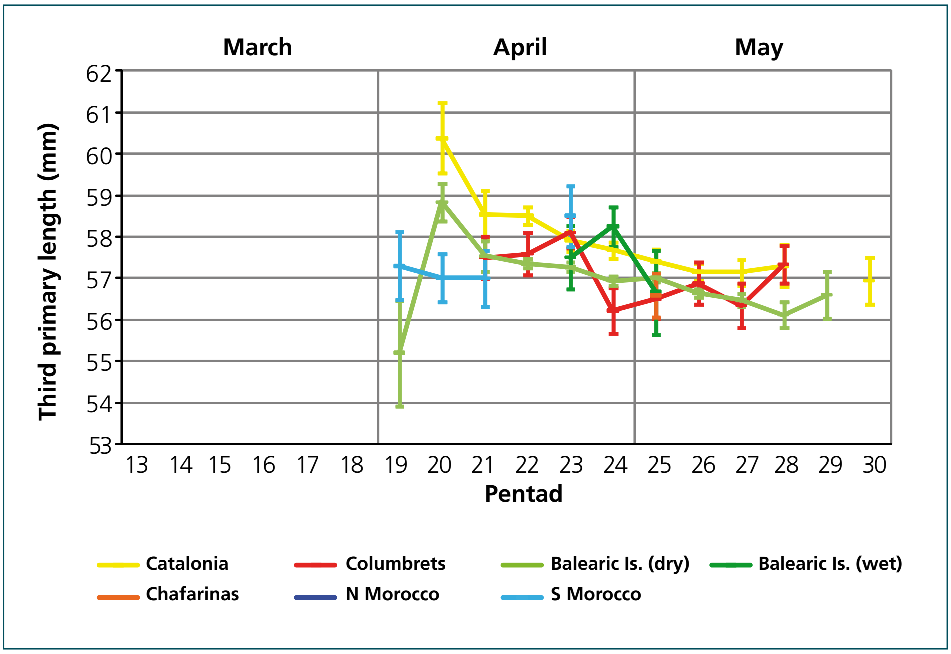


Figure 6. Temporal variation of third primary length according to area.

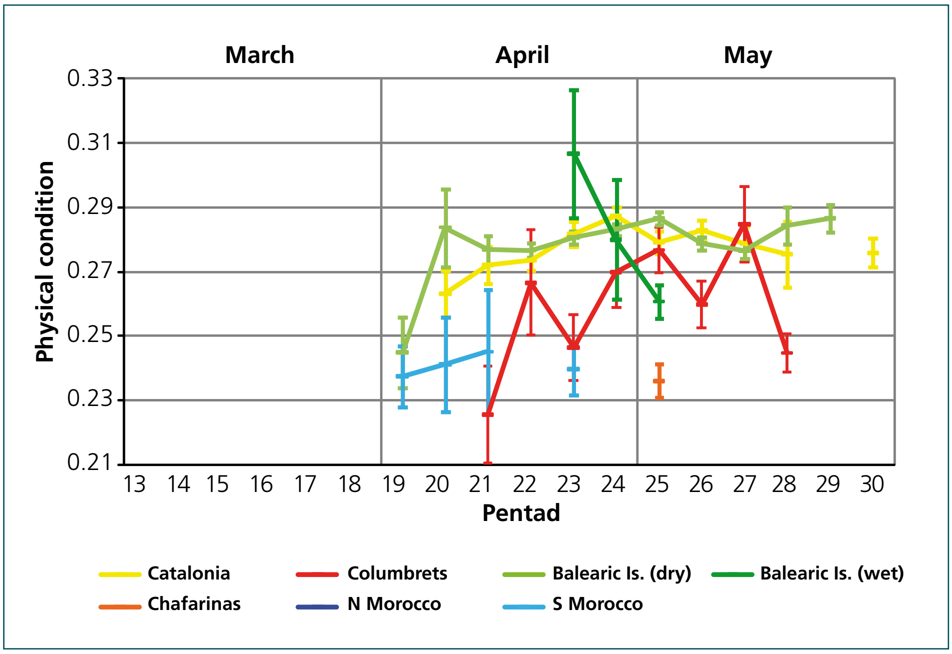


Figure 7. Temporal variation of physical condition according to area.

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

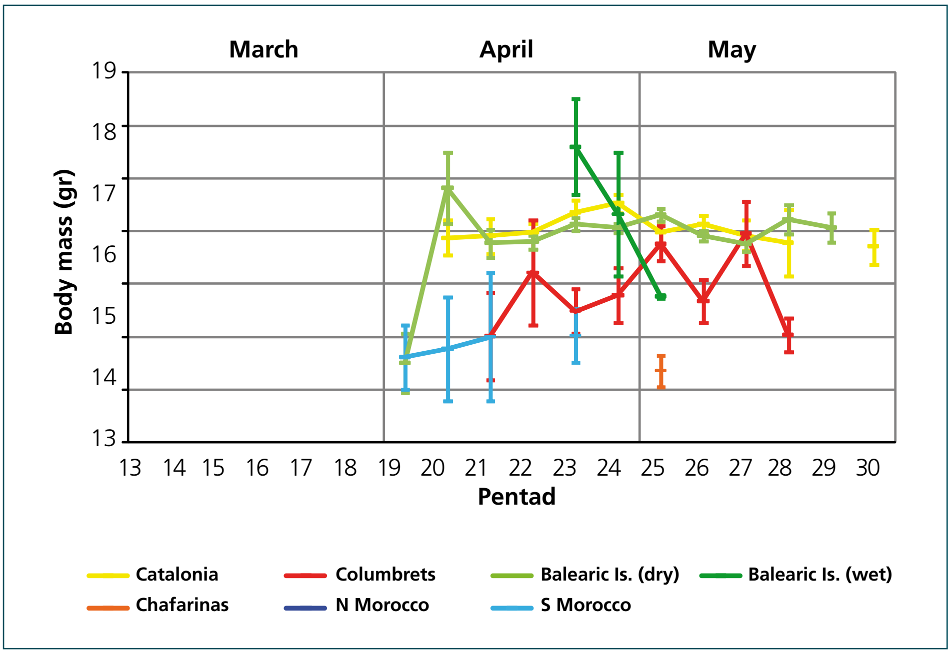
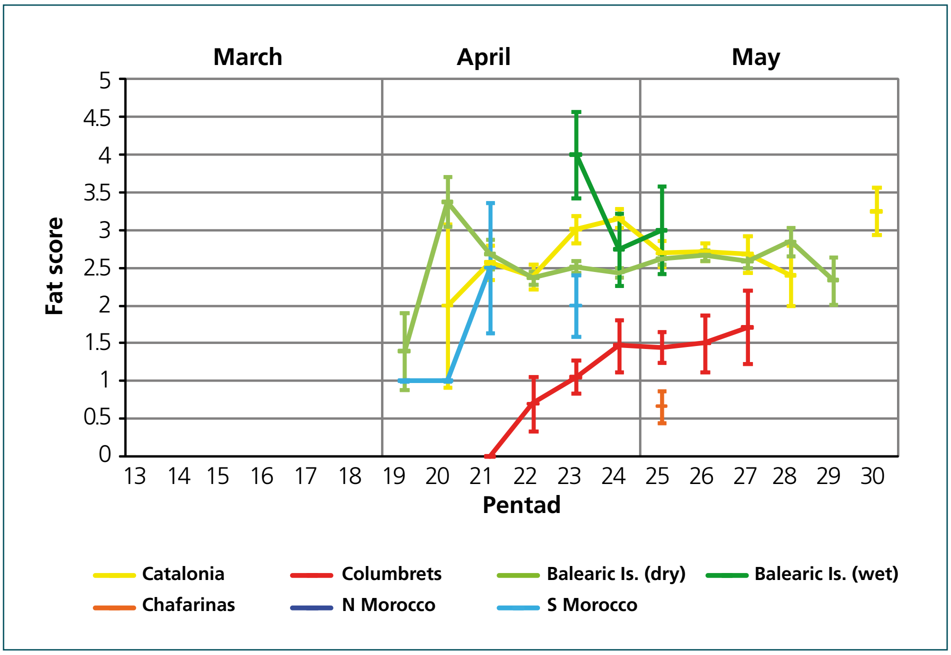


Figure 9. Temporal variation in fat score according to area.



Song Thrush
Turdus philomelos

Carles Barriocanal, David Robson, Ángel Sallent & Ángel Guardiola

Range

The Song Thrush breeds throughout most of Europe and westwards to Lake Baikal (Cramp, 1988; Hagemeijer & Blair, 1997). It is a partial migrant and its northern and eastern populations mostly winter in the Mediterranean region (Cramp, 1988). Individuals from further north, especially first-year birds, winter further south in N Africa and the Canary Islands (Cramp, 1998).

This species does not breed at any of the study sites, but is a common wintering species in sites such as the wet Balearics, N Morocco, Catalonia and on the larger islands of the dry Balearics (Cabrera, Formentera). In S Morocco and on the smallest islands no or very few wintering birds are present (L'Illa de l'Aire, Conillera, Els Columbrets, L'Illa Grossa and Las Chafarinas).

Migratory route

There are a fairly good number of recoveries in the study zone, although only one is direct (fig. 1). The main migratory route follows a clear SW-NE axis, with most birds originating from C and N Europe. Birds captured in S Spain originate from further north than those from the Balearics, which mostly involve birds from C Europe (mainly Germany, Switzerland and N Italy). The few recoveries of British origin have taken place in S and SE Spain in accordance with the longitudinal distribution of the different populations found on wintering grounds (Telleria et al., 1999).

Frequencies and number of captures show that most captures occur either on the islands that hold a good number of wintering birds (*e.g.* at Albufera d'Es Grau) or on tiny islands that attract a lot of migrants (fig. 2).

Phenology

Passage through the W Mediterranean begins mostly in February (Telleria et al., 1999; Thévenot et al., 2003), outside the study period. Passage, however, is most intense in March and then decreases and finishes in late April or early May (fig. 3). The two peaks in number of captures are due largely to a methodological artefact and reflect the fact that it is much easier to capture wintering birds in Catalonia and the Balearics at the beginning of the ringing campaigns (begun on 2 March in Catalonia and 17 March on the islands). This overall pattern of passage is similar to that reported in Gibraltar (Finlayson, 1992), La Camargue (Blondel & Isenmann, 1981) and the C Mediterranean (Petterson et al., 1990; Spina et al., 1993). The median date of passage occurs three days earlier in adults than in second-year birds (fig. 2).

Biometry and physical condition

Mean third primary length varies between 88.3 in the wet Balearics and 90.6 in N Morocco; the average wing length varies between 116.2 and 118.1 at the same sites, although without any significant differences between regions. These means are within the values recorded in spring in the C Mediterranean (mean 89.1, n = 355; Spina et al., 1993) and, in general, are similar to those reported all year round for C and N Europe (Cramp 1998) and NE Spain (ICO, 2010). In fact, this species does not show any appreciable variation in size throughout its distribution in the W Palearctic (Cramp, 1988). The third primary length decreases significantly over time (fig. 6), a trend that could be indicative of the differential migration of age/sex groups.

Mean body mass varies from 63.5 in the dry Balearics to 68.7 in Catalonia; fat scores range from 1.0 on Els Columbrets and in the wet Balearics to 2.3 in Catalonia. Birds are significantly heavier and fatter and in better physical condition in Catalonia than on Els Columbrets and in the Balearics; birds from the dry Balearics have more fat than on Els Columbrets. Otherwise, differences are inappreciable (table 1, figs. 7-9). Fat tends to increase significantly with time, particularly in Catalonia.

Available data from Gibraltar indicates somewhat higher figures than in N Morocco and Catalonia (mean 70.5, n = 14; Finlayson, 1981) and further confirms the fact that mass is clearly higher in continental areas than on insular sites, apparently reflecting the greater energetic demands made on birds undertaking sea-crossings. Further support for this view is the fact that mean body mass in the Tyrrhenian islands (mean 59.7, n = 355; Spina et al., 1993) is distinctly lower than in the Balearics/Els Columbrets, which lie closer to the important wintering grounds in N Africa.

Stopover

The number of retraps is very low in all study areas (fig. 5) and fuel deposition rates tend to be negative, but not significantly so (table 2). Available retraps indicate that the minimum stopover length is similar in all three areas, although 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	244	117.1 ± 2.7 (106.0-125.0)	89.4 ± 2.3 (82.0-95.5)	68.7 ± 7.0 (54.5-87.4)	2.3 ± 1.2 (0-5)
Columbrets	79	116.5 ± 2.9 (108.0-124.0)	88.6 ± 2.1 (82.0-93.0)	65.0 ± 7.3 (46.6-80.0)	1.0 ± 1.0 (0-4)
Balearics (dry)	379	116.6 ± 2.9 (104.0-127.5)	88.7 ± 2.3 (82.0-95.0)	63.5 ± 6.7 (47.7-88.1)	1.5 ± 1.1 (0-6)
Balearics (wet)	16	116.2 ± 1.8 (111.5-119.0)	88.3 ± 1.3 (86.0-91.0)	64.9 ± 6.4 (50.9-75.9)	1.0 ± 0.6 (0-2)
Chafarinas	0				
N Morocco	4	118.1 ± 4.1 (114.0-123.0)	90.6 ± 3.6 (87.0-94.0)	67.9 ± 8.3 (56.5-74.0)	2.0 ± 0.8 (1-3)
S Morocco	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	-1.98 ± 3.13 (6)		-0.25 ± 1.03 (9)	-2.31 ± 3.69 (2)		
Retraps >1 day	0.16 ± 0.43 (4)		-0.25 ± 1.03 (9)			

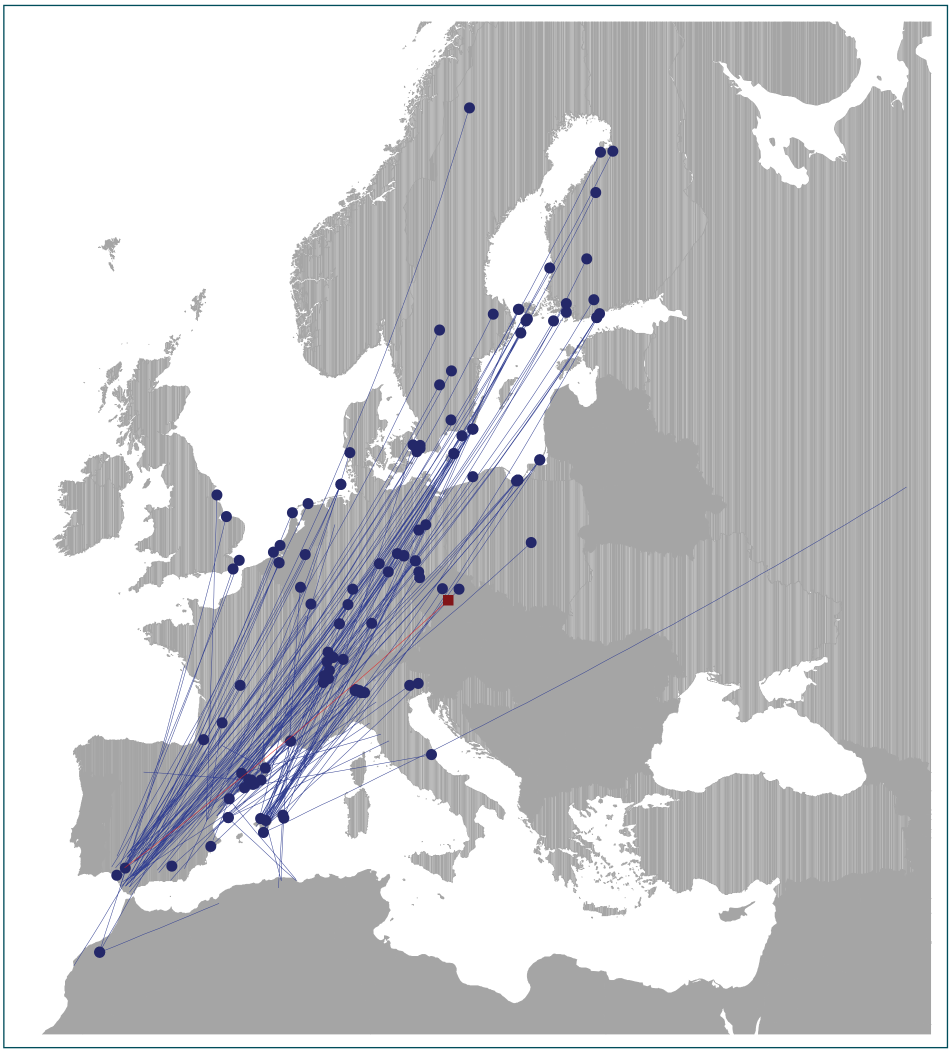


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

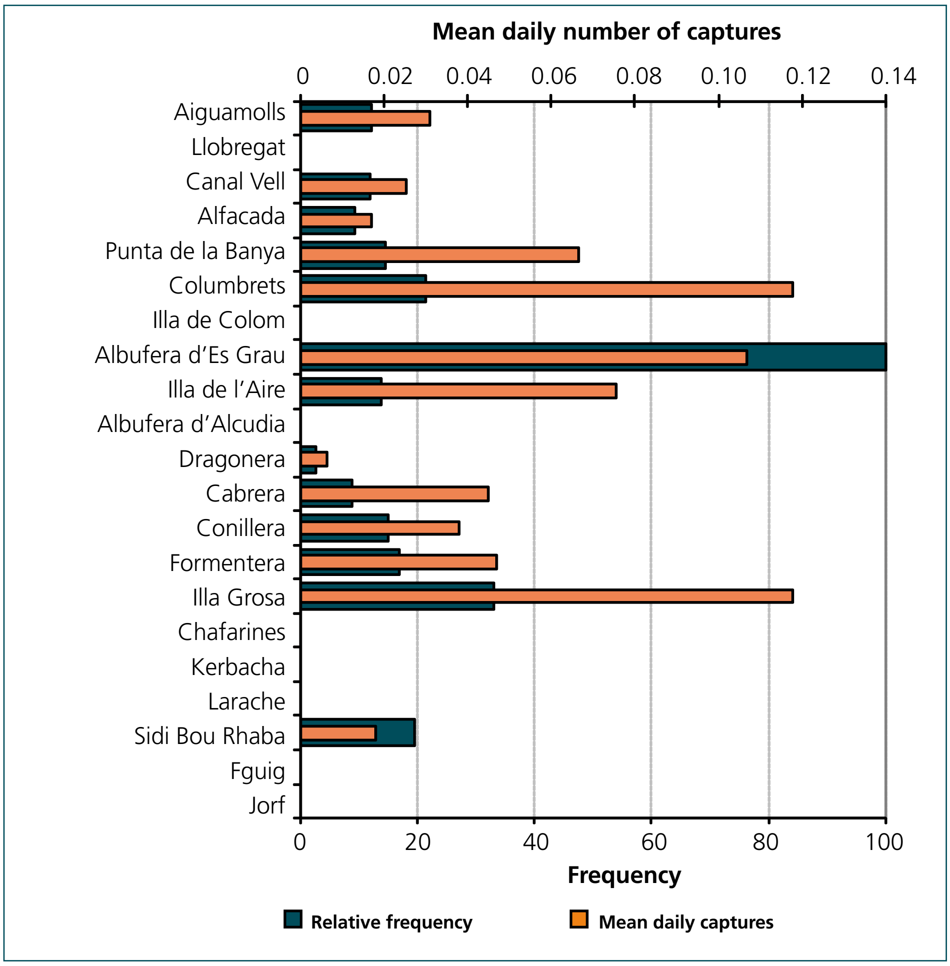


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

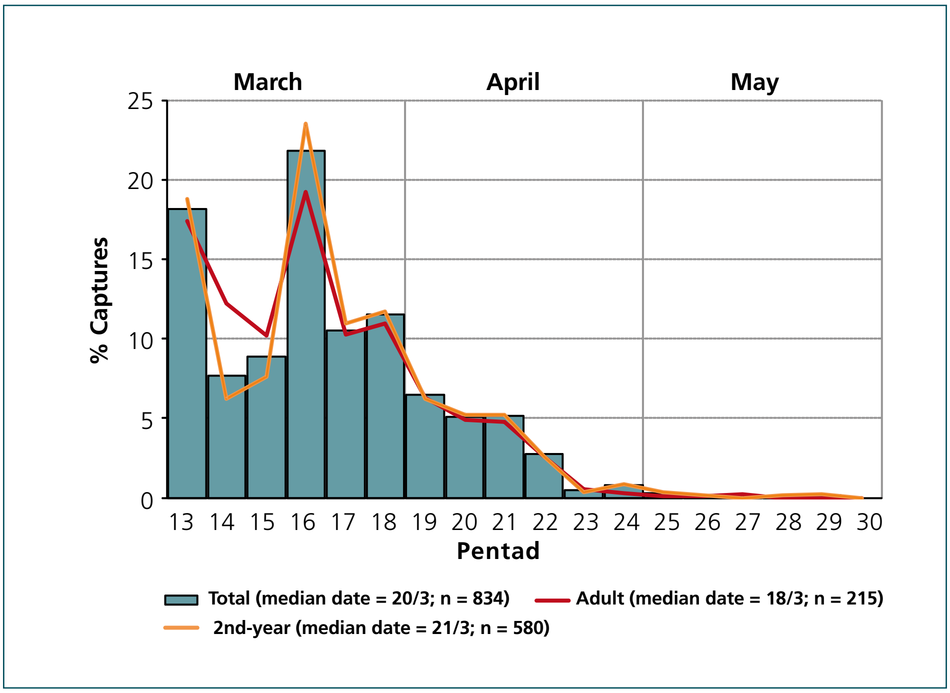


Figure 3. Frequency of captures during the study period.

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

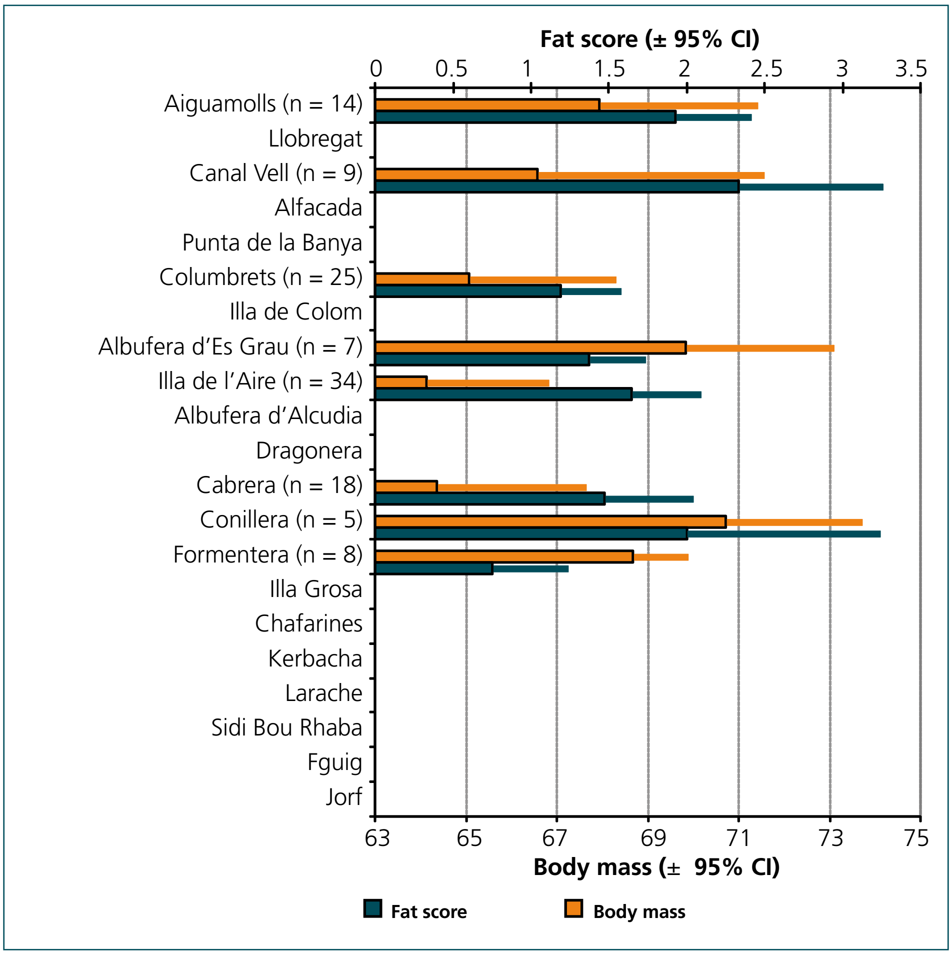
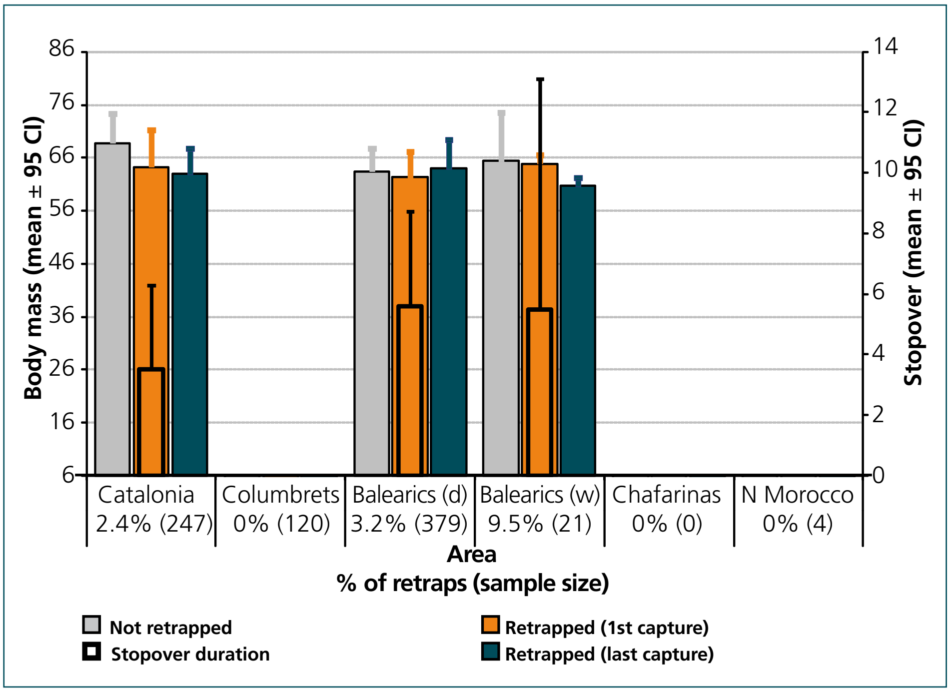


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



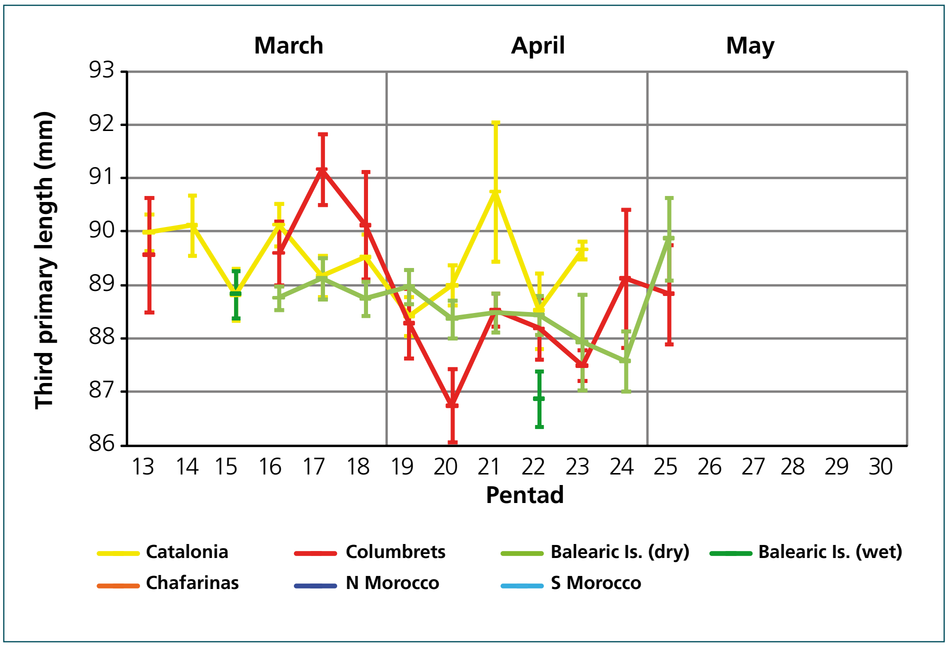


Figure 6. Temporal variation of third primary length according to area.

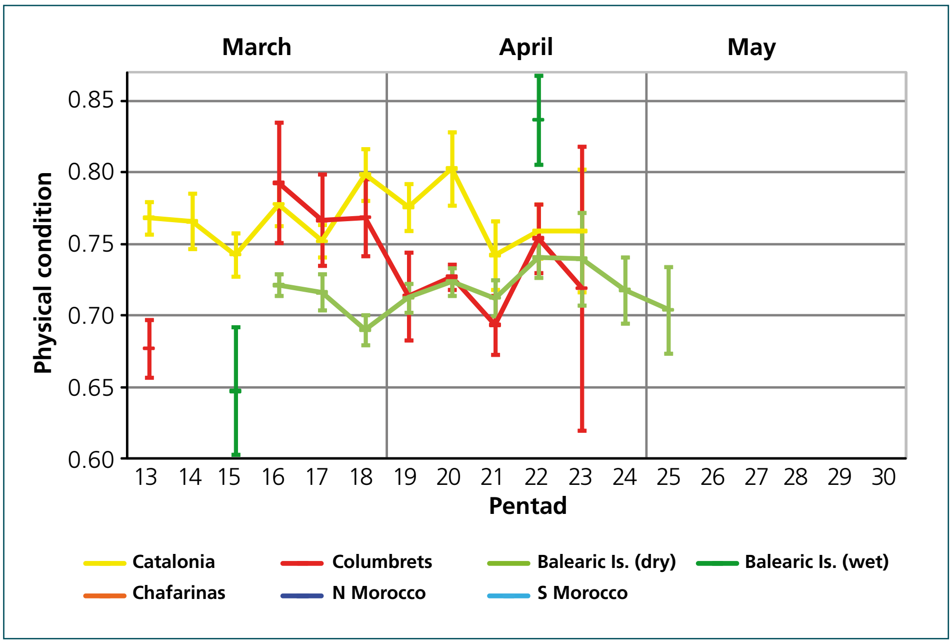


Figure 7. Temporal variation of physical condition according to area.

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

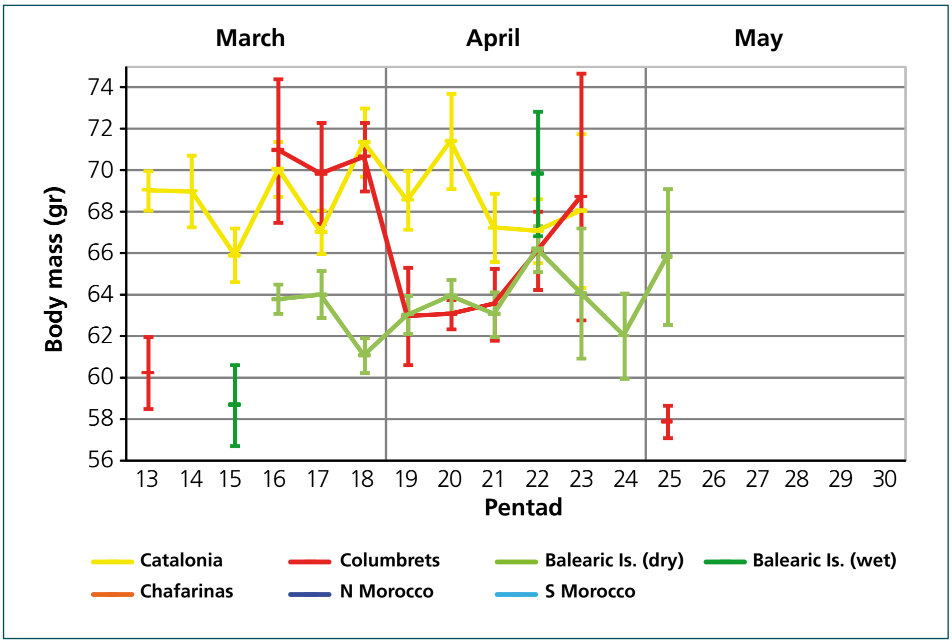
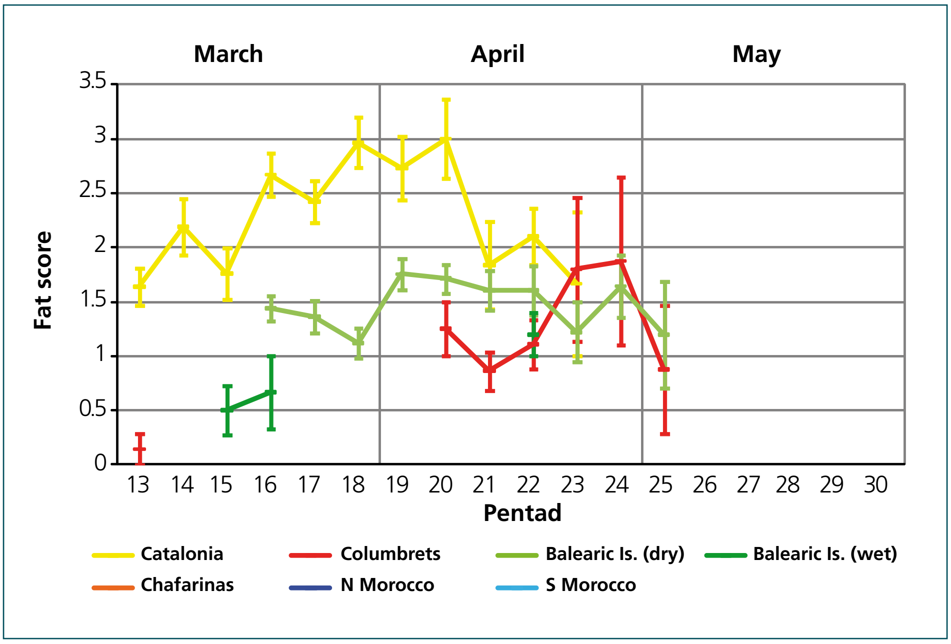


Figure 9. Temporal variation in fat score according to area.



Common Grasshopper Warbler

Locustella naevia

Iván Sánchez, Germán López-Iborra & Joan Castany

Range

The Common Grasshopper Warbler is a trans-Saharan migrant that is widely distributed across temperate areas of the W Palearctic (Simms, 1985). The nominate form breeds across a wide belt of C and N Europe, from the Spanish Cantabrian coastal strip north to Britain and S Scandinavia, and then eastwards to C Asia. In Europe it is fairly common, with an estimated total population of over 650,000 breeding pairs (Birdlife, 2004), the vast majority believed to winter in West Africa and irregularly in small numbers in Morocco (Cramp, 1992; Thévenot et al., 2003). It does not breed in the study area, despite old records of possible broods on the Catalan coast and along the Guadiana river (Tellería et al., 1999) that have not been confirmed by recent studies (Martí & Del Moral, 2003).

Migratory route

Despite being a common species, captures are scarce due to this warbler's skulking and terrestrial habits and consequently its migratory routes are some of the least known of all in the W Palearctic (Zink, 1973; Cramp, 1992). In autumn, many birds apparently leave Europe in a S (the more western population) or SW direction and thus cross over to Africa through the Iberian Peninsula (Smith, 1965; Thévenot & Thory, 1974; Cramp, 1992). Spain also seems to be a main point of entrance into Europe in spring since it is rare in the C Mediterranean (Spina et al., 1993) and extremely rare in Israel (Morgan & Shirihai, 1997). Moreover, the species' main –or at least best known– wintering grounds lie in the westernmost part of W Africa and it is uncommon but widespread throughout Morocco in spring (present data; Cramp, 1992; Thévenot et al., 2003). This view is further supported by spring recoveries that indicate a SW-NE migration axis from W Africa to Britain and from Spain to NE Europe, while others indicate NE movements from Algeria (fig. 1; Wernham et al., 2002). Migration may take place further eastwards in spring, as suggested by a spring recovery in the Balearics of a bird ringed the previous September in SW Portugal.

In general, the largest daily capture rates and highest frequencies occur in Catalonia and on islands such as Els Columbrets, L'Illa de l'Aire and Cabrera (fig. 2). These insular sites are also some of the most isolated and where birds average lowest body masses (fig. 4), suggesting that to some degree these sites act as attraction points for many birds. But overall, the number of birds trapped in the Balearics and on Els Columbrets is strikingly high and certainly indicates that a substantial number of birds cross the Mediterranean through this area. Despite the figures from Catalonia and many insular sites, the species is relatively less frequent in the wetlands of N Morocco.

Phenology

The main passage period is relatively short, with most birds passing though the area between late April and mid-May (fig. 3). The first individuals captured at the beginning of April signal the start of a progressive increase in numbers during this month; the last birds are captured at the end of May after a steep decline in numbers from mid-May onwards. Passage is similar in all main areas (Catalonia, the Balearics/Els Columbrets and N Morocco), although the sample size is small from Morocco and data from March are very scarce. In fact, in Morocco passage generally seems to take place earlier, with some birds already passing through in late February, although the bulk of the migration occurs from mid-March to mid-May (Thévenot et al., 2003). Migration also seems to take place a little earlier at Gibraltar and birds pass through the area from late March onwards, mostly during April and early May (Finlayson, 1992). In Switzerland, passage occurs about ten days later than in NE Spain, with the first arrivals usually present by mid-April (Maumary et al., 2007).

Biometry and physical condition

Mean values for third primary lengths range from 48.6 on Els Columbrets to 49.4 in N Morocco (table 1). Mean values for wing lengths vary from 64.4 in the dry Balearics to 65.0 in Catalonia. Birds from Catalonia have on average longer third primaries than birds on Els Columbrets and in the dry Balearics, which suggests that smaller birds may tend to stop on isolated islands more frequently than larger birds. Third primary length tends to decrease with time (fig. 6).

Mean values of fat score between 2.6 in the dry Balearics and 3.6 in Catalonia, while mean body mass varies from 13.0 to 14.0 at the same sites (table 1). Birds from Els Columbrets and the dry Balearics have the lowest values for fat and weight, and in both cases their averages are significantly lower than for birds trapped in Catalonia (probably due to a higher presence of drop-outs in the sample). However, while individuals captured at N Morocco have an average fat score similar to those captured in Catalonia, their mean body mass is rather similar to that on Els Columbrets / Balearic Islands. The average body mass recorded in Britain in spring is similar to in N Morocco (mean 13.1, n = 24, Baggott, 1986; Cramp, 1992). In Catalonia, mass, fat and physical condition increase significantly during the season, but no clear trend is observed in the dry Balearics, the other area with good number of captures (figs. 7-9).

Available data from SE Morocco shows that birds trapped there are in poorer condition than in N Morocco and body mass and fat reserves are *c.* 11% and 30% lower, respectively (means of 11.7 and 2.3, respectively, n = 19; Gargallo et al., unpubl.). On the other hand, the fact that birds from the Balearics and Els Columbrets have similar body mass to those from N Morocco indicates that at least those undertaking sea crossings have to have larger reserves when leaving N Africa. All this suggest that birds gain mass in some areas of NW Africa, both to regain energetic reserves lost crossing the Sahara and in preparation for crossing the Mediterranean. As shown by the state of birds in Catalonia and their stopover behaviour (see below), this species seems to be able to continue gaining mass along its route across S Europe and reach more northern parts of range (*e.g.* Britain) with a remaining fat load of *c.* 12% (Baggott, 1986).

Stopover

The percentage of retraps is small in all areas, although slightly higher in Catalonia (7.6%; fig. 5, table 2). Stopover length does not differ between areas and is also rather short (2.5-3.5 days). In Catalonia, however, birds have a positive fuel deposition rate, which is significant when considering retraps of more than one day and higher than on Els Columbrets/Balearic Islands, where birds do not show significant fuel gains. These differences seem to indicate the importance of wetlands as stopover sites during migration, as has been noted in the literature, despite being a species that does not favours these areas for breeding (Cramp, 1992; Baily & Rumsey, 2007). It should be taken into account, however, the fact that the habitat conditions in the dry and isolated islands studied here can be particularly unsuitable for this warbler.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	321	65.0 ± 1.9 (60.0-76.0)	49.3 ± 1.6 (45.0-54.5)	14.0 ± 1.4 (10.1-18.0)	3.6 ± 1.3 (0-6)
Columbrets	74	65.0 ± 1.9 (60.5-69.0)	48.6 ± 1.3 (45.5-51.5)	13.1 ± 1.7 (10.3-17.4)	2.8 ± 1.6 (0-7)
Balearics (dry)	277	64.4 ± 1.8 (60.0-69.0)	48.9 ± 1.6 (44.0-53.5)	13.0 ± 1.7 (9.1-17.7)	2.6 ± 1.6 (0-7)
Balearics (wet)	3	64.7 ± 0.6 (64.0-65.0)	48.8 ± 0.3 (48.5-49.0)	13.7 ± 1.9 (12.1-15.8)	3.0 ± 2.0 (1-5)
Chafarinas	1		48.5	10.2	1.0
N Morocco	13	65.0 ± 2.4 (60.5-69.0)	49.4 ± 2.0 (46.0-53.0)	13.1 ± 1.4 (11.0-14.8)	3.3 ± 1.1 (2-5)
S Morocco	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	-0.59 ± 0.89 (21)	-0.15 ± 0.66 (24)	0.21 ± 0.32 (112)	-0.64 ± 0.91 (2)		
Retraps >1 day	0.19 ± 0.15 (7)	-0.41 ± 0.50 (13)	0.01 ± 0.26 (51)			

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

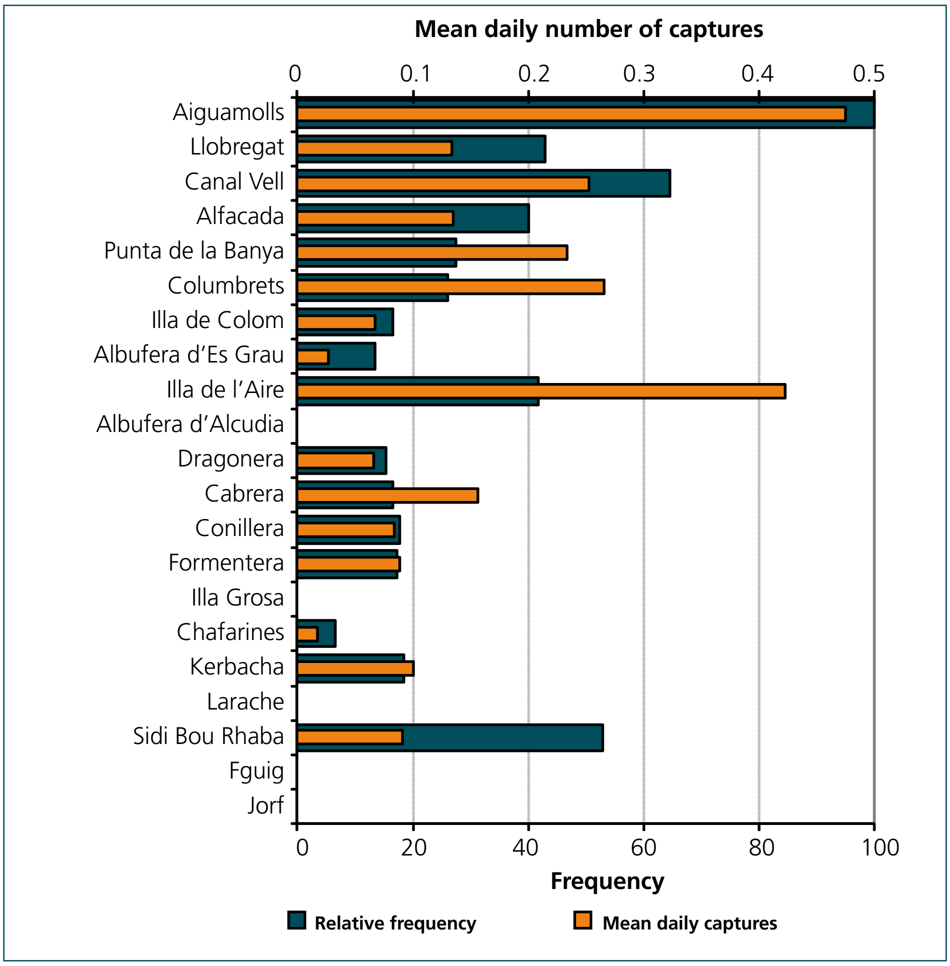


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

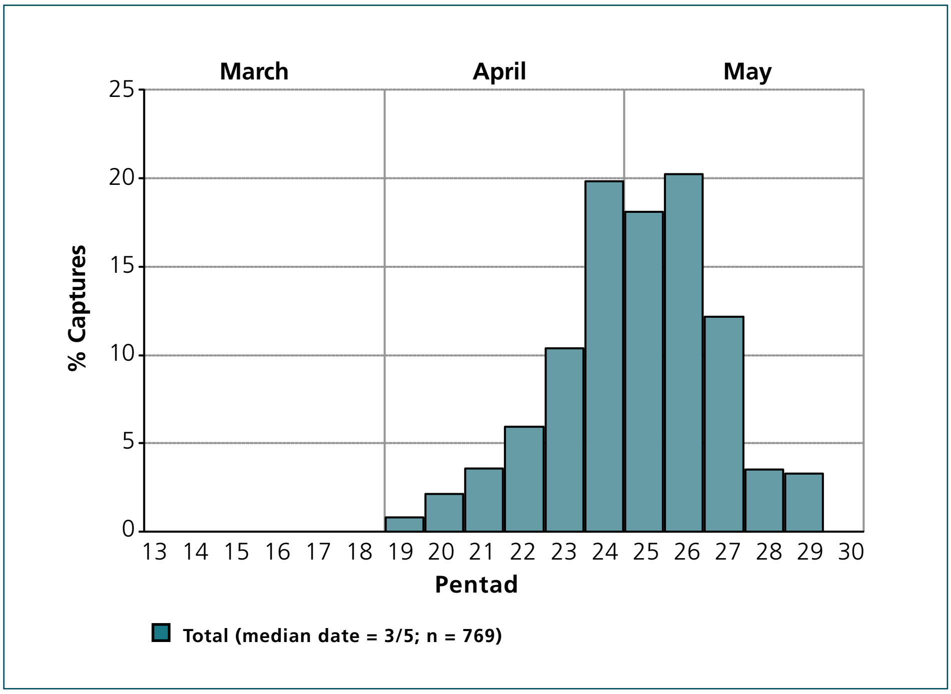


Figure 3. Frequency of captures during the study period.

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

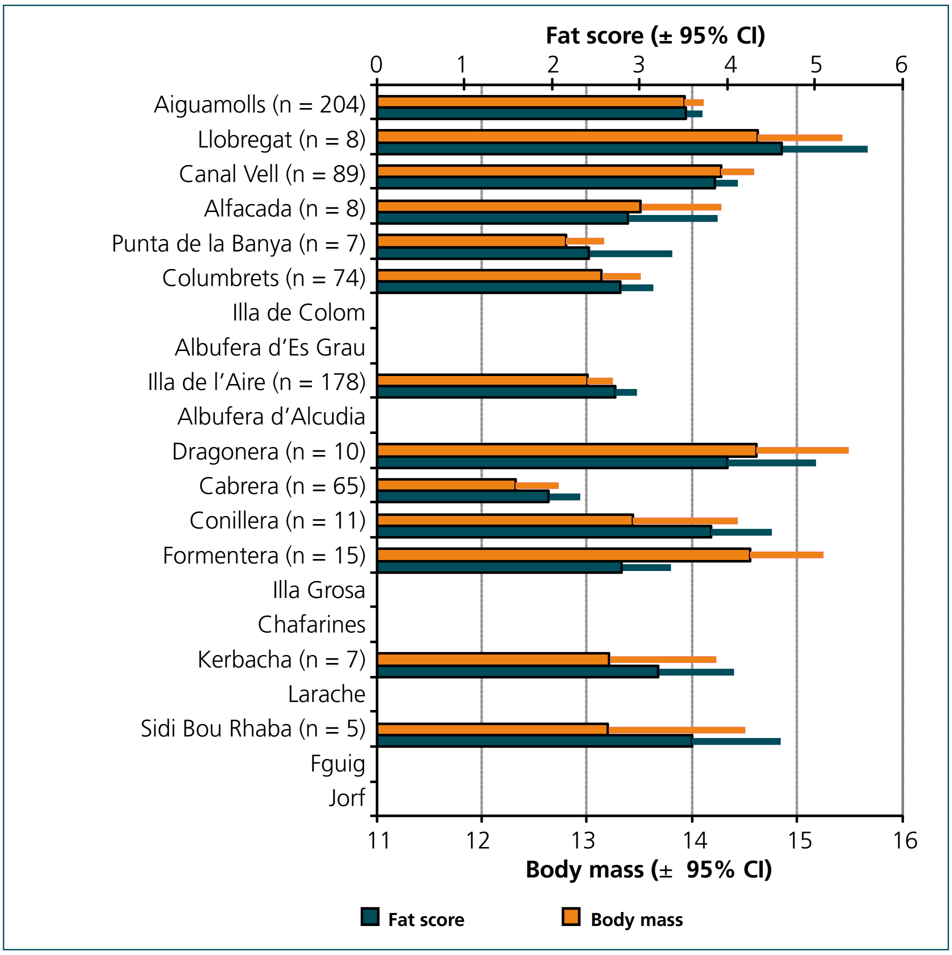
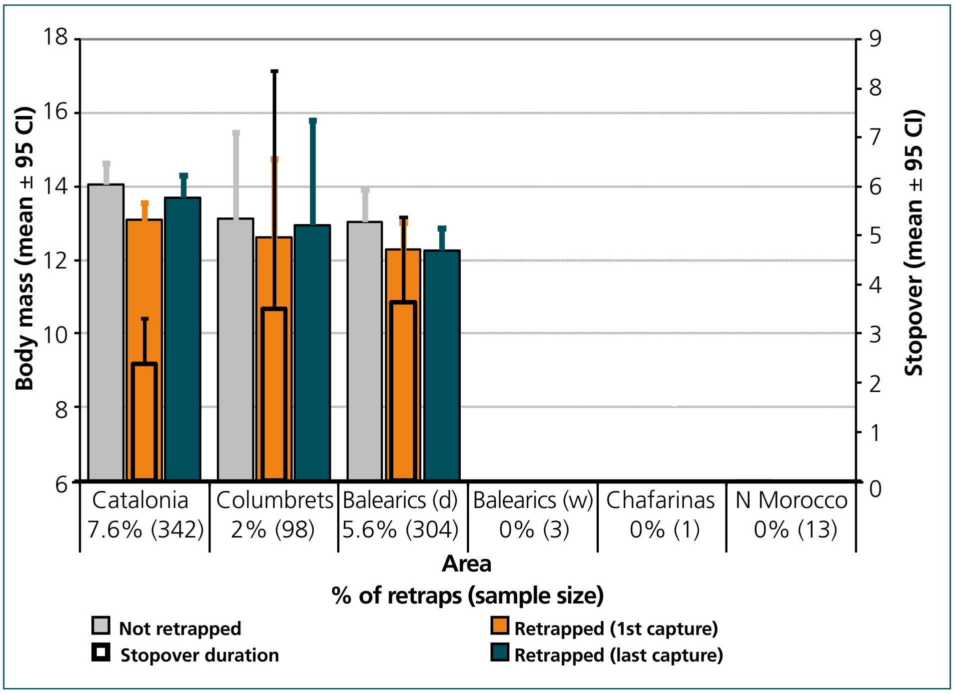


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



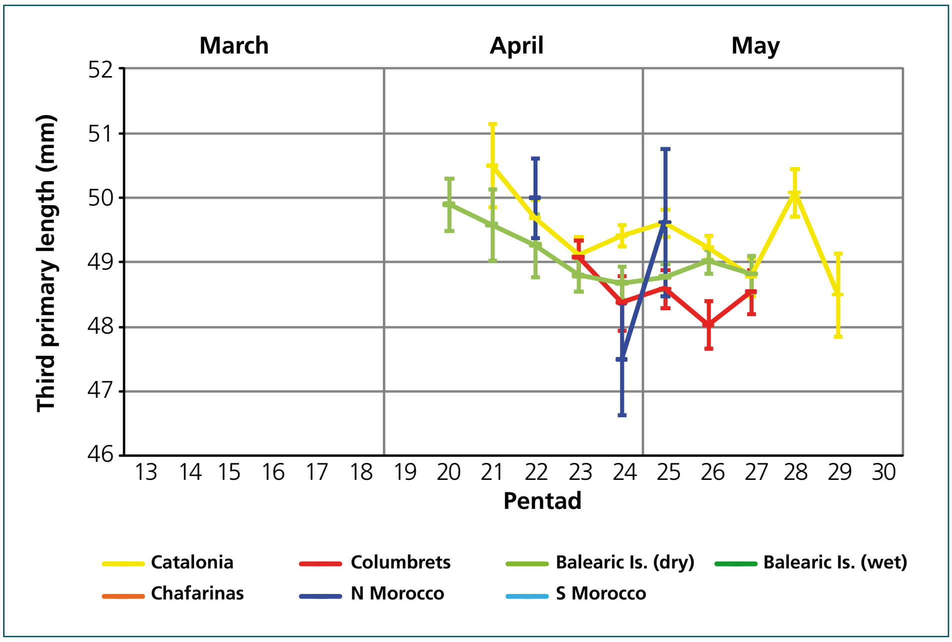


Figure 6. Temporal variation of third primary length according to area.

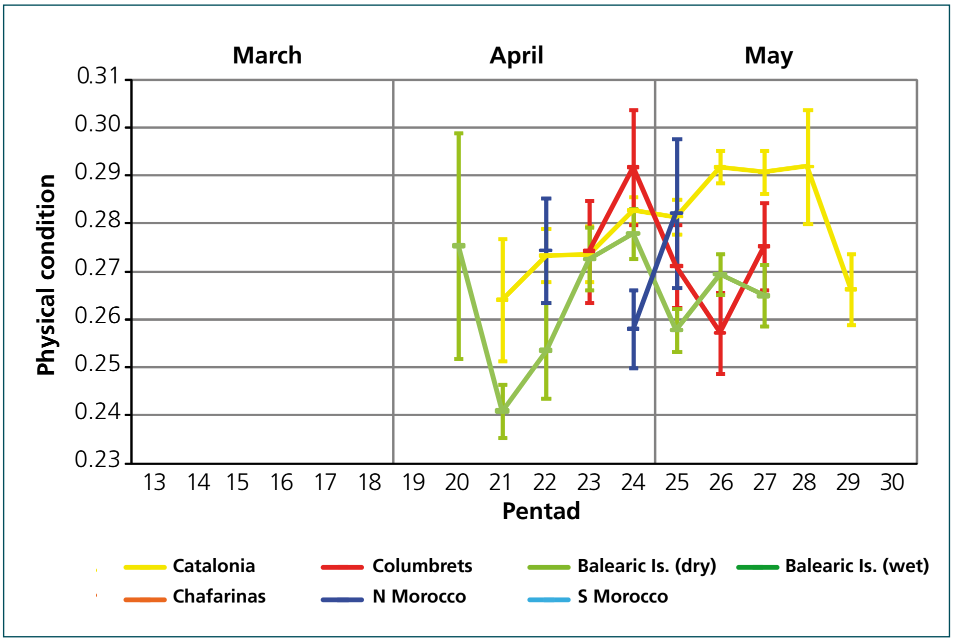


Figure 7. Temporal variation of physical condition according to area.

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

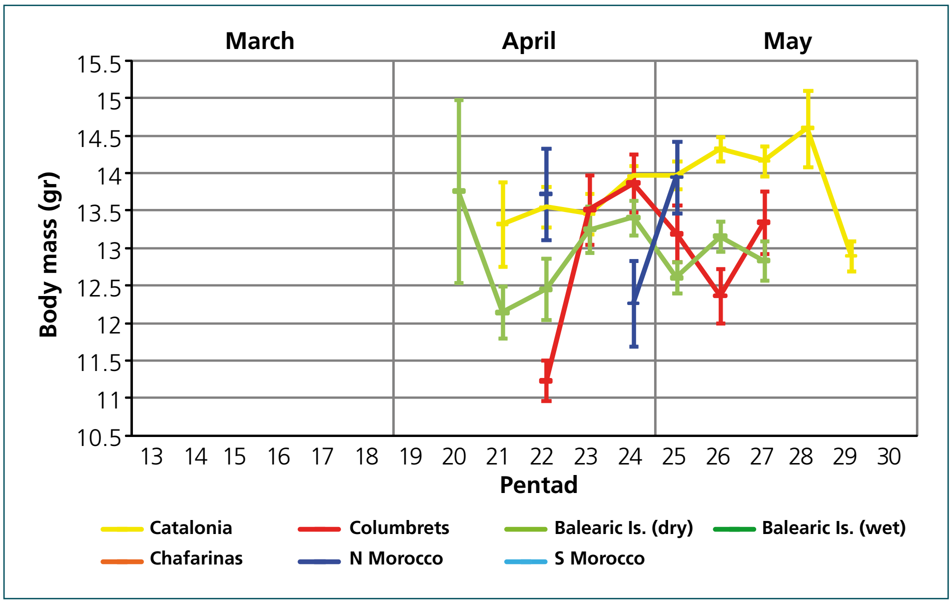
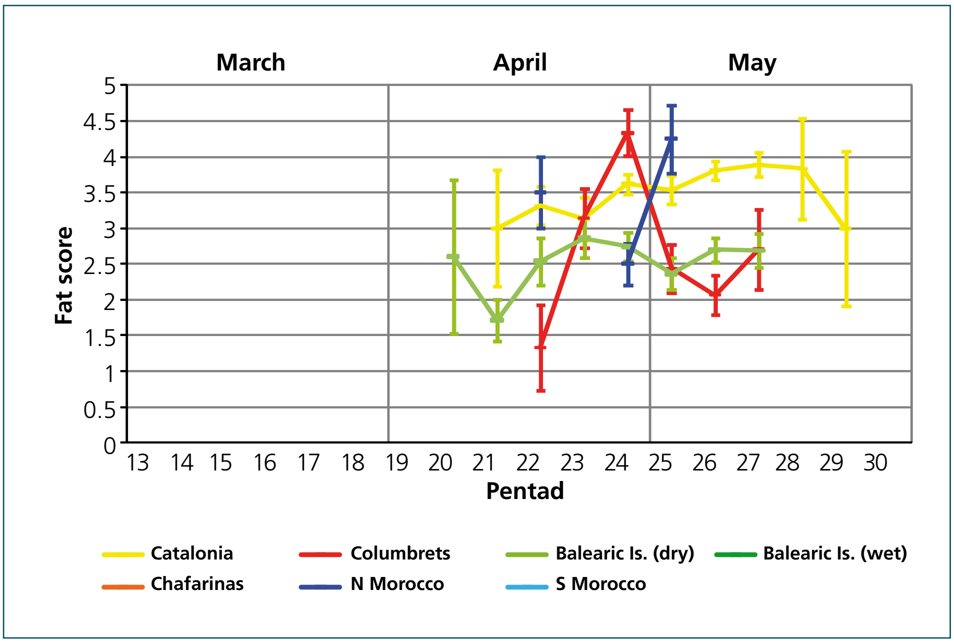


Figure 9. Temporal variation in fat score according to area.



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)

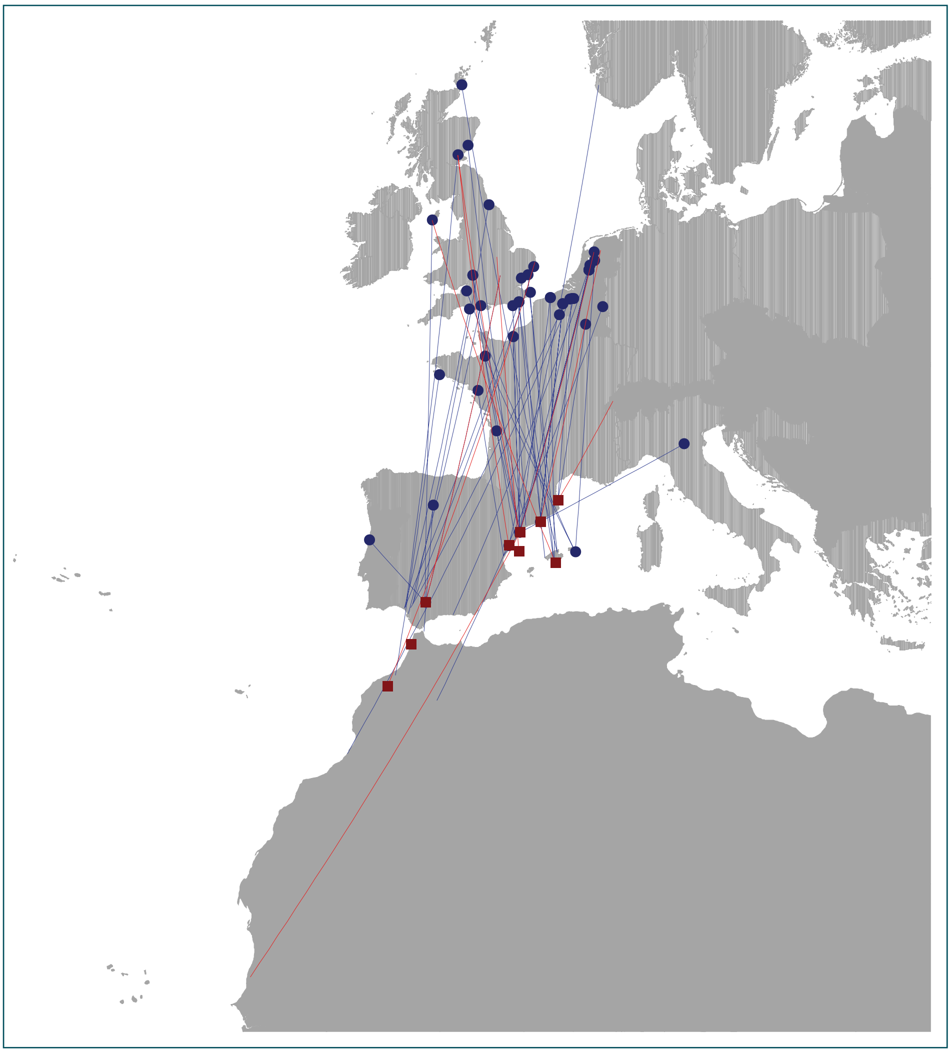


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

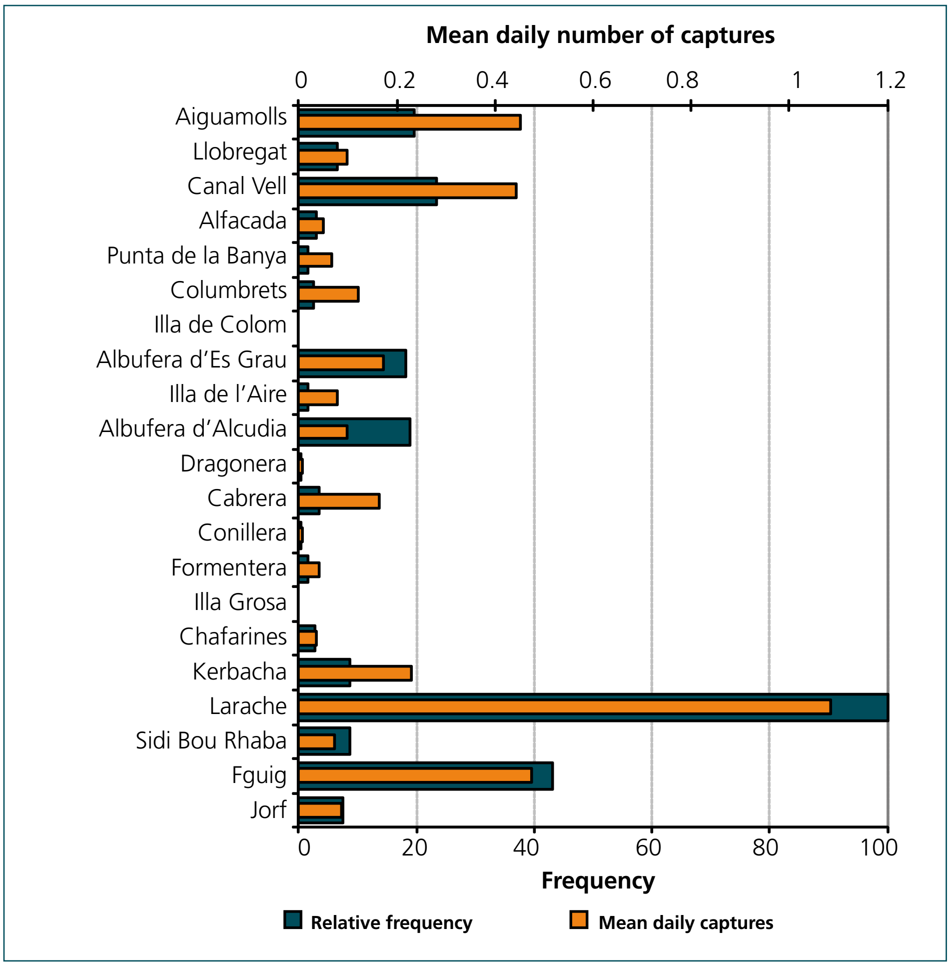


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

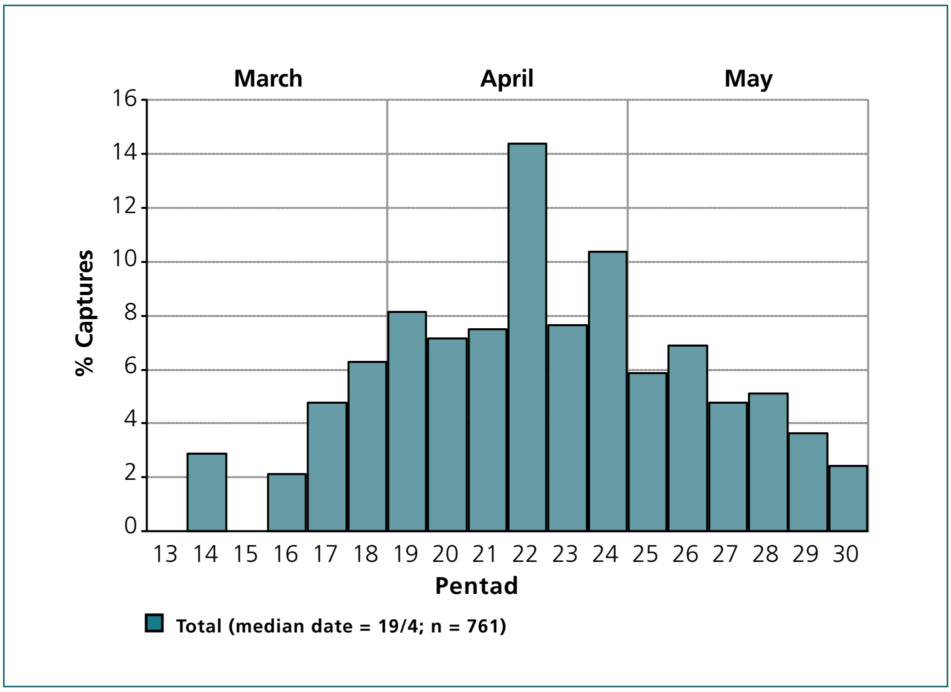


Figure 3. Frequency of captures during the study period.

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

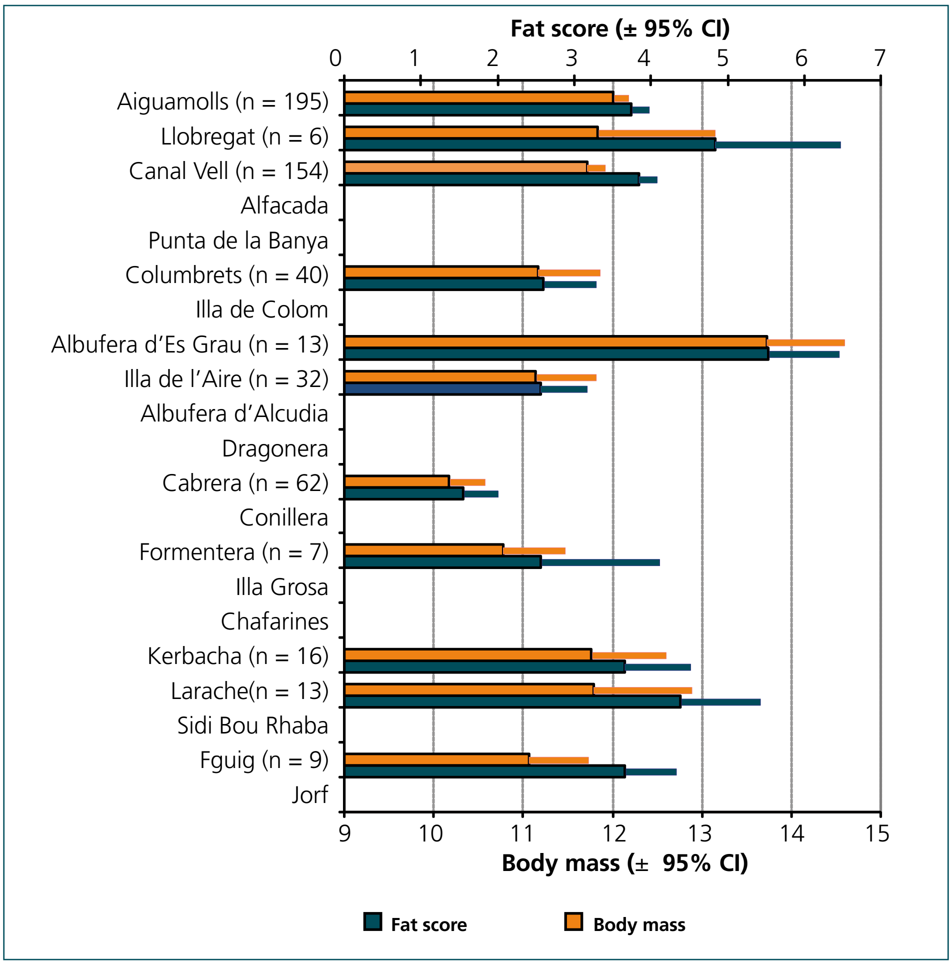
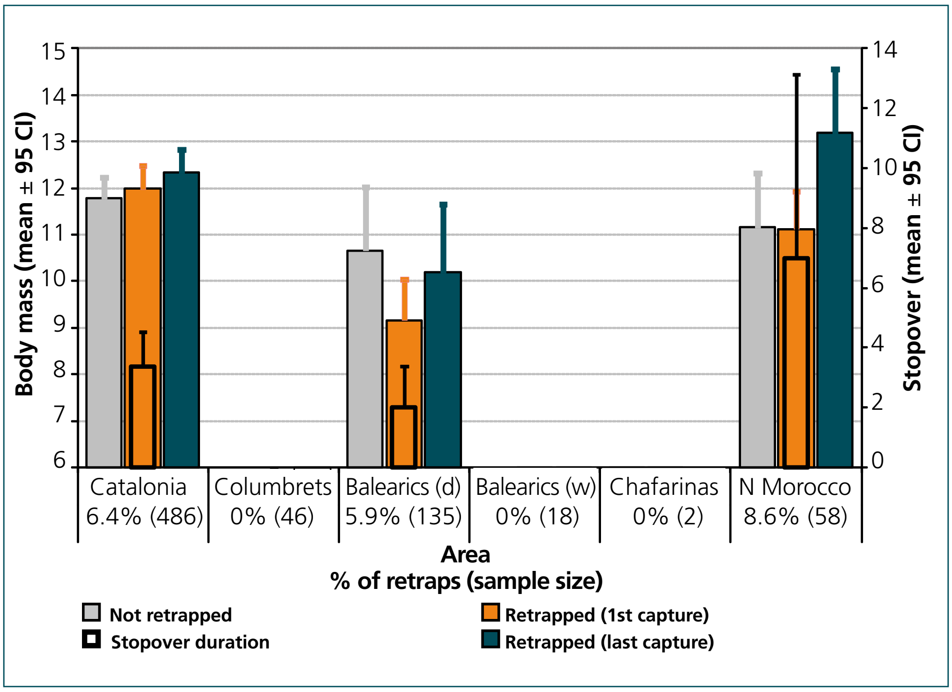


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



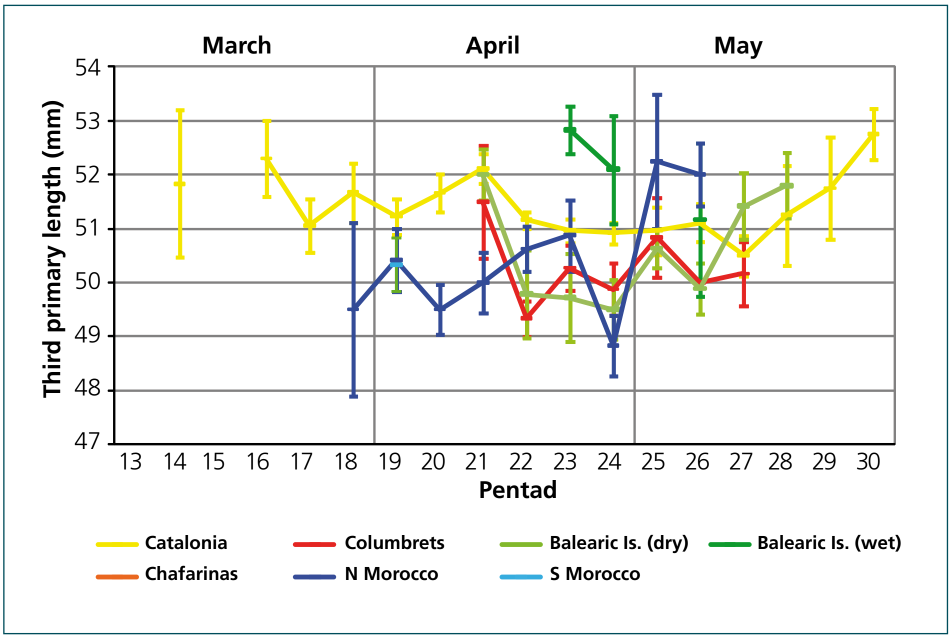


Figure 6. Temporal variation of third primary length according to area.

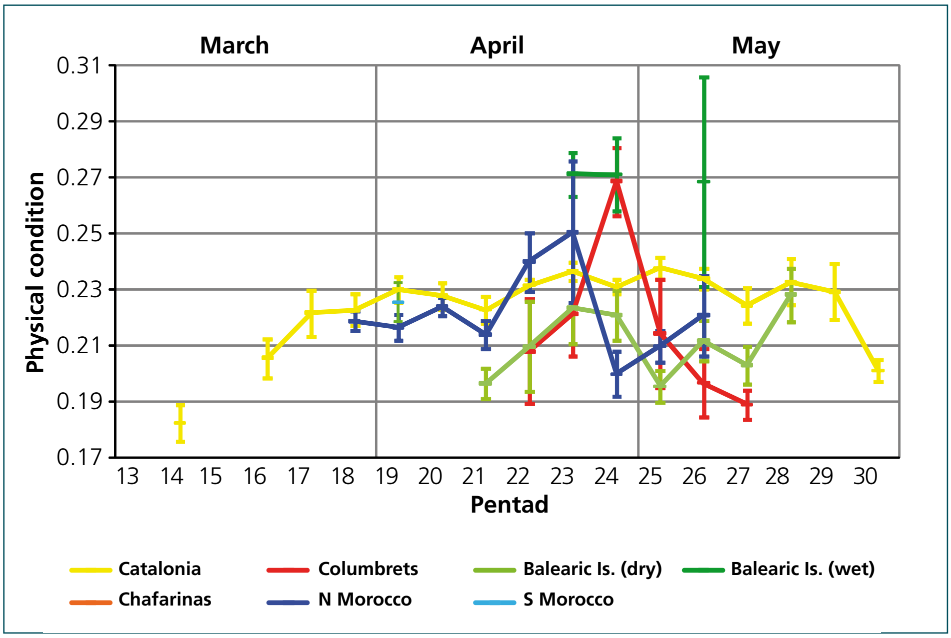


Figure 7. Temporal variation of physical condition according to area.

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

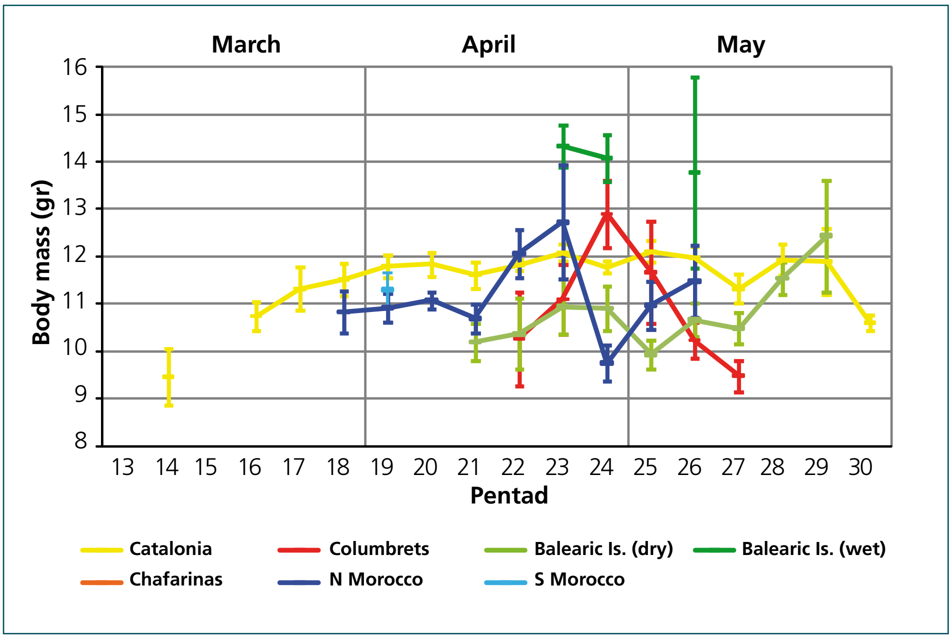
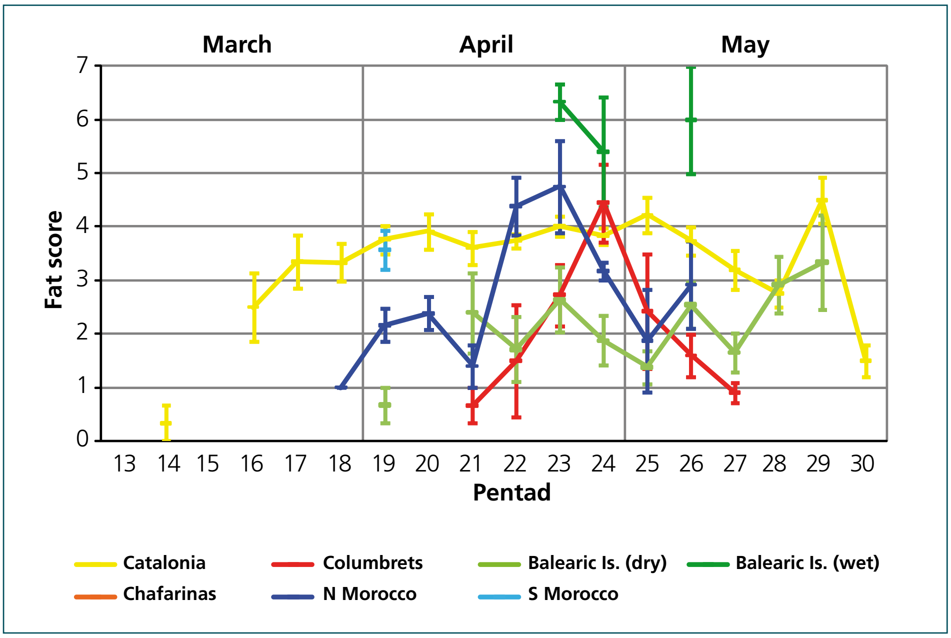


Figure 9. Temporal variation in fat score according to area.



Reed Warbler
Acrocephalus scirpaceus

Hamid Rguibi-Idrissi

Range

The Reed Warbler breeds throughout much of Europe and parts of WC Asia, but is absent from most northern regions and only patchily distributed in the Mediterranean Basin (Cramp, 1992). Local populations overwinter in Morocco and there are occasional winter records from SW Europe; nevertheless, the vast majority of birds winter in tropical Africa, with W European populations wintering almost exclusively in W Africa (Moreau, 1972; Cramp, 1992; Urban et al., 1997; Thévenot et al., 2003; Rguibi-Idrissi et al., 2007; Zwarts et al., 2009; Jiguet et al., 2010). In terms of the study sites, the Reed Warbler breeds in all Catalan wetlands and L'Albufera d'Alcúdia (Balearics). In Morocco it only breeds at Larache and in very low numbers at Sidi Bou-Rhaba; at the rest of the sites it is only recorded on migration. Even when breeding birds are present (with the exception of L'Albufera d'Alcúdia), the vast majority of captures are of non-local migrants.

Migratory route

Recoveries show that the main movements through Morocco and Spain are in a N-NE direction, becoming more NE or even nearly E in Catalonia, indicating that birds avoid crossing large stretches of sea and enter Europe largely through S Spain. Birds heading more towards SC and E Europe circumvent the W Mediterranean sea along the coast of NE Spain and S France (fig. 1). This would explain the large number of captures in N Catalonia (*e.g.* Els Aiguamolls) and the scarcity of recoveries and captures from the Balearics/Els Columbrets and the islands of the C Mediterranean (fig. 2; Spina et al., 1993). Overall, spring migration through the area follows a similar route to that reported in autumn (Zink, 1973; Cramp, 1992; Rguibi-Idrissi, 2002; Fransson & Stolt, 2005; Rguibi-Idrissi et al., 2007), although in spring birds largely avoid the westernmost part of the Iberian Peninsula. Interestingly, the few recoveries from the Balearics/Els Columbrets show distinctly a more N axis of movement and a more NW European origin, markedly different to that shown by birds migrating through Catalonia (mean direction 13°NE and 46°NE, respectively). Given that the species has a clear inclination to avoid sea-crossing, this striking result may signify that those that do cross the W Mediterranean directly tend to be birds returning to breeding grounds along a more direct N route, possibly delayed birds that need to make up time (*cf.* Barriocanal & Robson, 2006). However, drifting may also play a role (see "Concluding remarks" for further details).

The wetlands of N Morocco produce some of the greatest number of captures and highest relative frequencies (fig. 2) and the importance of this area is further highlighted by the larger proportion of recoveries obtained in NW Africa in spring than in autumn (Fransson & Stolt, 2005).

Phenology

The first few individuals are captured in late March; numbers then increase slowly during April to the main passage period in May, peaking during second half of this month and clearly continuing in good numbers at least until early June (fig. 3). This phenology is roughly similar to that reported in S France and Tunisia (Jarry, 1980; Blondel & Isenmann, 1981; Cramp, 1992). In Morocco passage takes place earlier, from late February to mid-March on the Atlantic Coast and in the south, and from mid-March in the NE (Thévenot et al., 2003; Rguibi-Idrissi et al., 2007; Gargallo et al., unpubl.). In S Spain and Gibraltar passage is from March onwards, but mostly in April-May (Finlayson, 1992; Telleria et al., 1999; pers. obs.). Recoveries do not show any correlation regarding time of passage and latitude of capture.

The present data do not reveal significant differences in phenology between the Balearics and Catalonia, although Barriocanal & Robson (2006) found that birds undertaking direct sea crossings are somewhat delayed compared to those migrating over land (Barriocanal & Robson, 2006).

Biometry and physical condition

Mean values for third primary lengths range from 50.2 in S Morocco to 52.0 in Catalonia, similar to values reported from the C Mediterranean (mean 51.9, n = 4; Spina et al., 1993; table 1). Mean values for wing lengths vary from 65.6 in S Morocco to 67.0 in Catalonia, and are also similar to those reported elsewhere in W Europe (Cramp, 1992). Birds from Morocco have significantly shorter third primary lengths, reflecting the higher presence of more southern, smaller populations (Cramp, 1992; pers. obs.). The third primary length shows a clear tendency to decrease over time, suggesting that males and adults (of larger size; Cramp, 1992) migrate earlier (fig. 6). In fact, males are known to arrive at their breeding grounds two-three weeks earlier than females; as well, adults precede second-year birds and migrate faster (Cramp, 1992; Rguibi-Idrissi et al., 2003).

Mean fat score values lie between 1.5 (Els Columbrets) and 3.0 (wet Balearics; table 1), and are distinctly lower in the dry Balearics and, especially so, on Els Columbrets than in Catalonia. Birds captured at L'Albufera d'Es Grau are heavier and have larger fat reserves than in most other insular sites (fig. 4). Mean body masses vary between 10.1 in Las Chafarinas to 11.5 in the wet Balearics and Catalonia (table 1). Birds from the dry Balearics and Els Columbrets show similar figures to those reported from other islands in the C Mediterranean (mean 10.47, n = 44; Spina et al., 1993) and significantly lower than in Catalonia, particularly so in the latter case. Body mass and physical condition in N Morocco is lower than in Catalonia, although the poorest body conditions are detected in S Morocco, Las Chafarinas and Els Columbrets (table 1, fig. 8). In the Netherlands and England reported means are similar to Catalonia (11.8, n = 19 and 11.5, n = 28, respectively; Cramp, 1992) and at Gibraltar marginally lower (mean 11.0, n = 7; Finlayson, 1981). Birds captured in S Morocco have similar body mass to those reported from a nearby site (10.2, n = 314, Gargallo et al., unpubl.), but are markedly heavier than the small number of birds measured by Ash (1969) in the region (mean 9.0, n = 15). These figures are significantly lower than in N Morocco by *c.* 6-17%. Body mass, fat and physical condition tend to decrease during the season (figs. 7-9).

As suggested also by recoveries and capture data, together these results indicate that N Morocco is a relevant refuelling area for Reed Warblers in spring (see also Rguibi-Idrissi, 2002; Rguibi-Idrissi et al., 2003, 2004). Overall, however, mass gain is not marked and body mass and condition is even slightly lower than in Catalonia. Once in S Europe, therefore, birds seem able to gain a limited amount of mass, although the similarity of body mass across S and W Europe suggests that birds largely move in short flight bouts that do not require long stopovers or substantial new gains in mass (*cf.* also Robson et al., 2001; see below also). The fact that the condition of birds trapped in the dry Balearics/Els Columbrets is similar or only slightly lower than in N Morocco suggests that birds crossing the sea depart from N Africa with a much higher body mass average that than observed in N Morocco.

Stopover

The percentage of retraps is lowest in the dry Balearics, Catalonia and, above all, on Els Columbrets, but reaches *c.*11% in N Morocco and the wet Balearics (fig. 5). In N Morocco and Catalonia the fuel deposition rate is significantly positive, particularly for retraps of more than one day, and birds end up gaining mass during their stay, although only very slightly so in Catalonia (table 2). In the wet Balearics the fuel deposition rate is significantly negative, but the sample is very small and perhaps too influenced by the presence of local breeding birds; in the dry Balearics, birds staying more than two days are able to gain some mass and show positive fuel deposition rates. The stopover length is highest in N Morocco, but is perhaps overestimated due to the presence of a few local birds since at Kerbacha –where the species does not breed– the mean stopover length is 4 days (n = 65). This figure is closer to that obtained in Catalonia, where stopover time is distinctly longer, than to all the insular areas (except the wet Balearics). In the dry Balearics retrapped birds are clearly lighter when first captured than non-retrapped birds, but in Catalonia only very slightly so. In the other areas differences are not significant.

Results reveal the importance of N Morocco as a refuelling area in spring, birds being very likely to stop there for longer periods of time and to gain more mass faster. Figures are very similar to previous studies (Rguibi-Idrissi, 2002; Rguibi-Idrissi et al., 2003, 2004) and to those reported at Eilat, S Isreal (Yosef & Chernetsov, 2005). Birds migrating through continental Spain tend to stopover less frequently than in N Morocco and to gain less mass, similar behaviour to that previously reported in Catalonia and other parts of Europe (Robson et al., 2001; Bolshakov et al., 2003b) and further corroborating previous biometrical analyses (see above). Data from small and isolated Mediterranean islands indicate that a good number of birds are forced to stop there due to poor body condition.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	9,396	67.0 ± 2.1 (54.5-75.0)	52.0 ± 1.9 (41.0-60.0)	11.5 ± 1.1 (7.4-18.2)	2.9 ± 1.4 (0-8)
Columbrets	228	66.9 ± 2.7 (54.5-75.0)	51.6 ± 1.9 (43.0-57.5)	10.3 ± 1.2 (8.0-16.4)	1.5 ± 1.2 (0-7)
Balearics (dry)	664	66.5 ± 2.1 (60.0-73.0)	51.7 ± 1.9 (44.5-59.0)	11.1 ± 1.5 (7.9-18.6)	2.6 ± 1.5 (0-7)
Balearics (wet)	39	66.5 ± 2.2 (62.0-71.2)	51.8 ± 1.8 (48.0-56.0)	11.5 ± 1.3 (9.1-14.0)	3.0 ± 1.7 (0-6)
Chafarinas	19		51.0 ± 1.8 (47.5-53.5)	10.1 ± 0.9 (8.4-11.8)	1.7 ± 1.2 (0-5)
N Morocco	1,139	65.8 ± 2.4 (57.0-73.5)	50.5 ± 2.0 (42.5-60.0)	10.8 ± 1.3 (7.6-17.7)	2.7 ± 1.4 (0-7)
S Morocco	85	65.6 ± 2.5 (59.0-71.0)	50.2 ± 2.2 (45.0-54.0)	10.2 ± 1.3 (7.8-15.0)	2.4 ± 1.1 (0-5)

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	0.06 ± 0.06 (462)	-0.21 ± 0.57 (5)	-0.09 ± 0.15 (43)	-0.25 ± 0.17 (5)	0.06 ± 0.31 (2)	0.13 ± 0.09 (142)
Retraps > 1 day	0.12 ± 0.04 (255)	0.07 ± 0.39 (2)	0.18 ± 0.18 (15)	-0.07 ± 0.10 (2)		0.14 ± 0.06 (104)

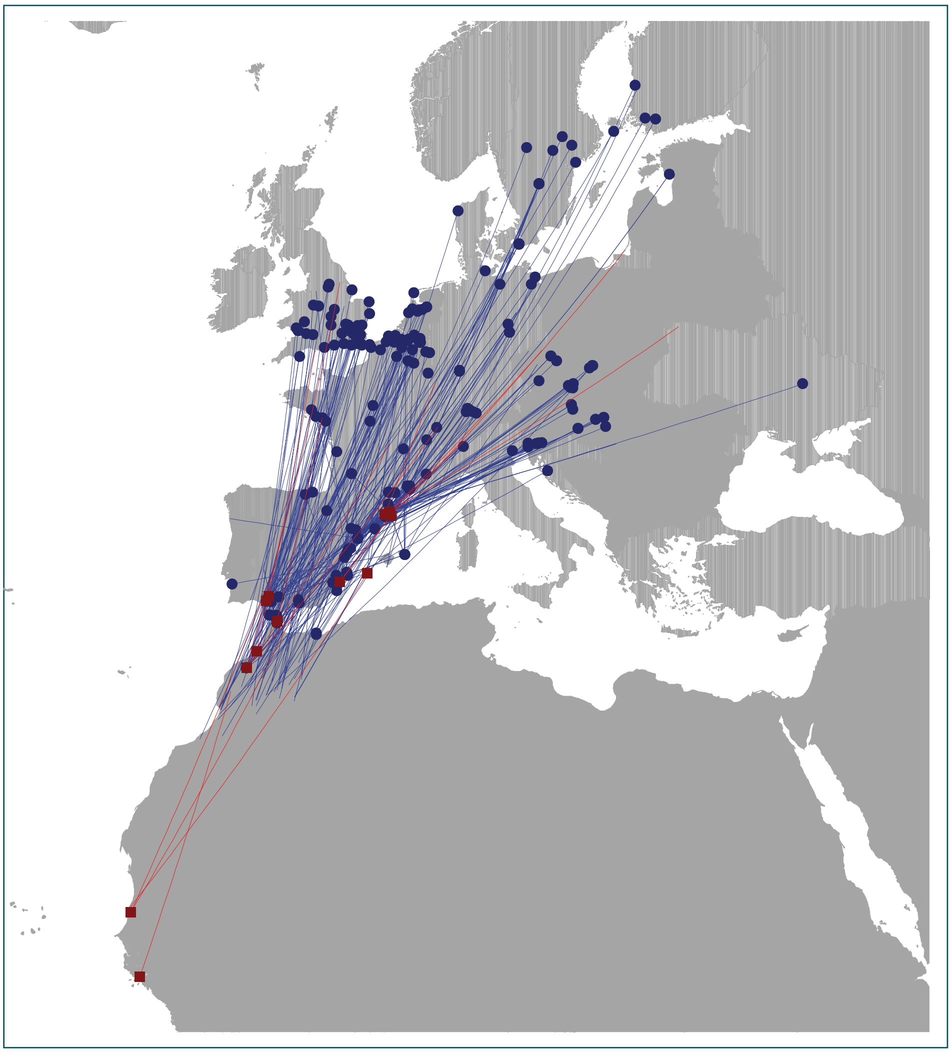


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

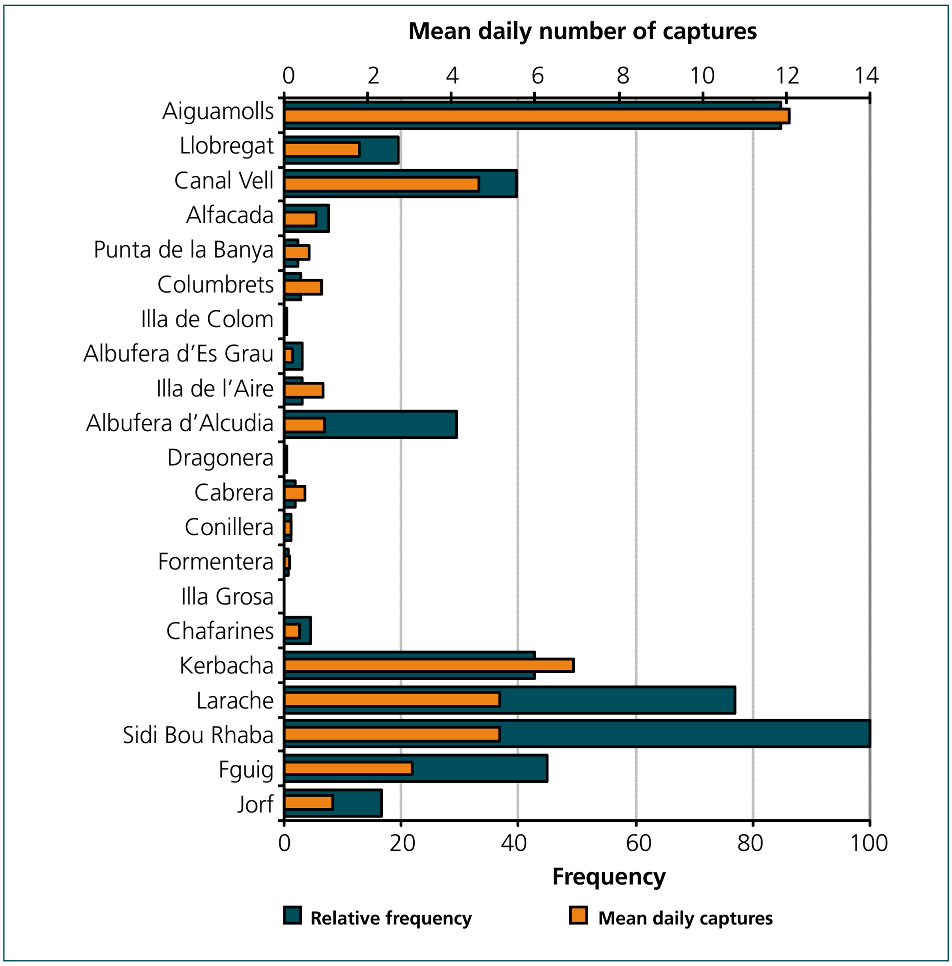


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

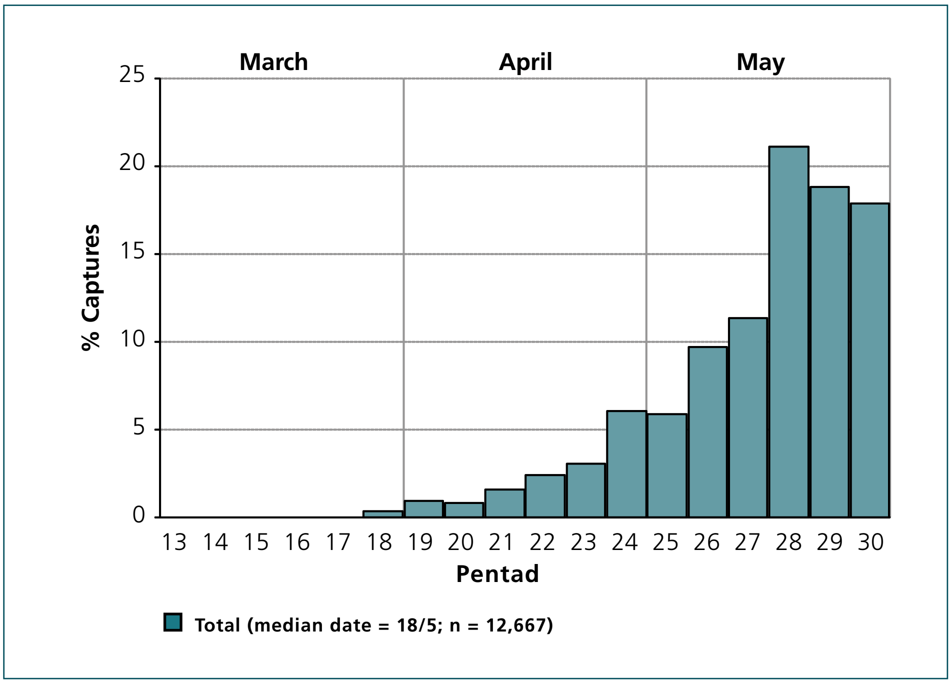


Figure 3. Frequency of captures during the study period.

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

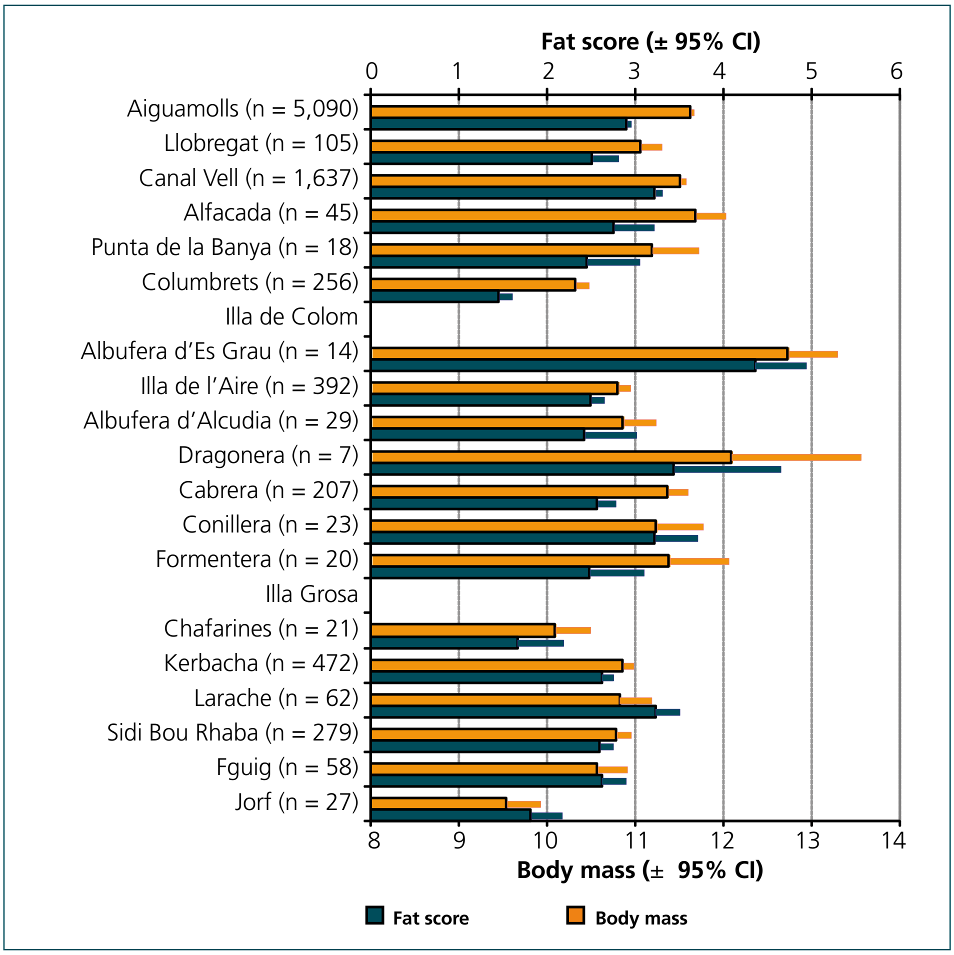
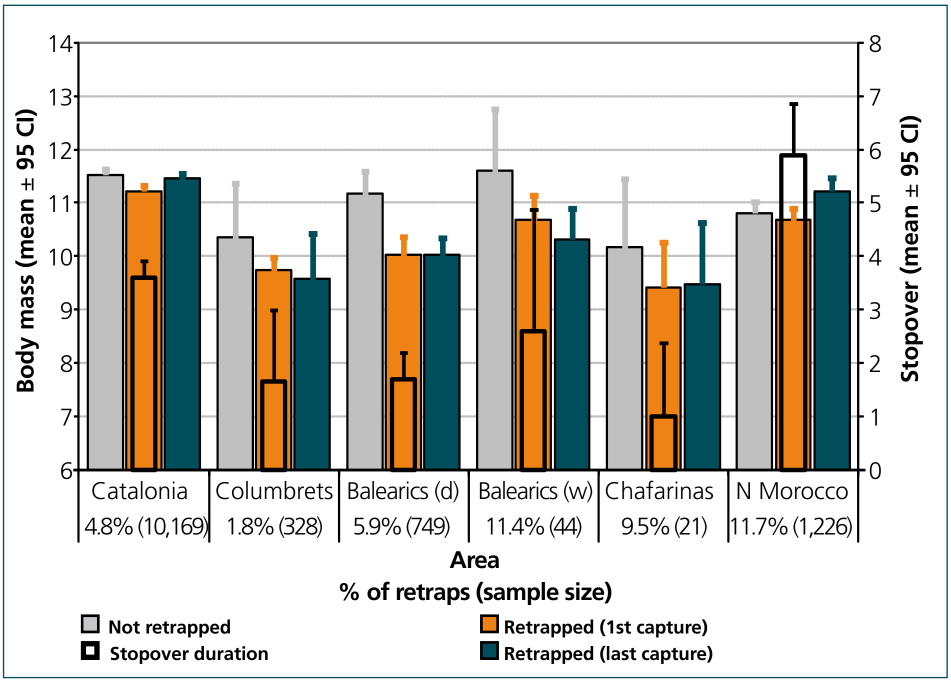


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



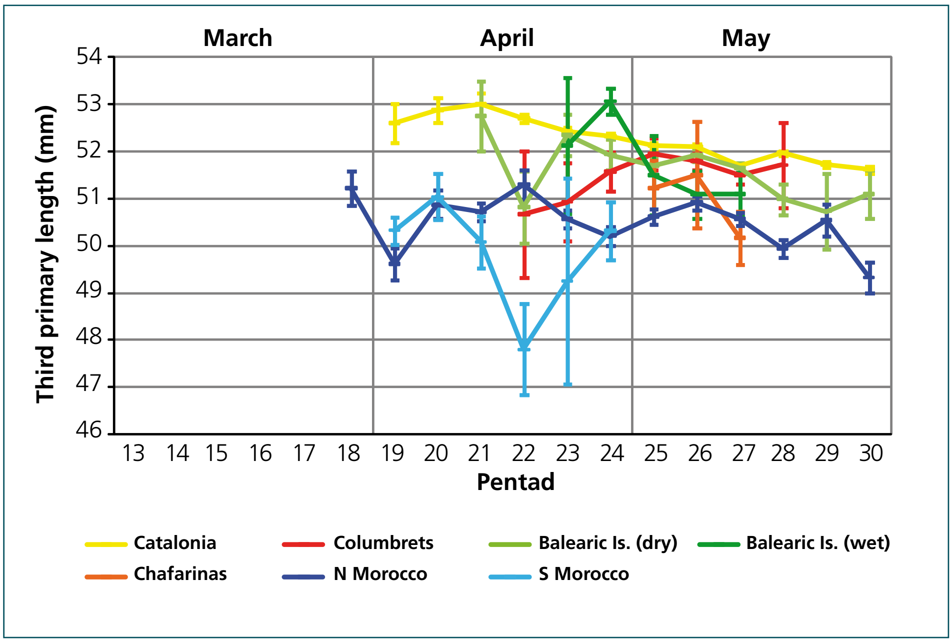


Figure 6. Temporal variation of third primary length according to area.

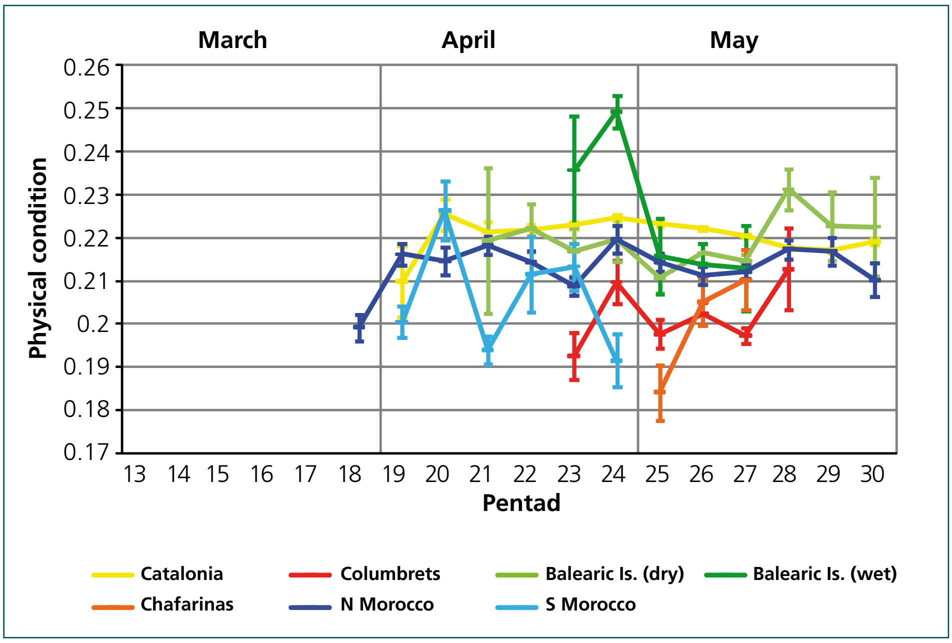


Figure 7. Temporal variation of physical condition according to area.

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

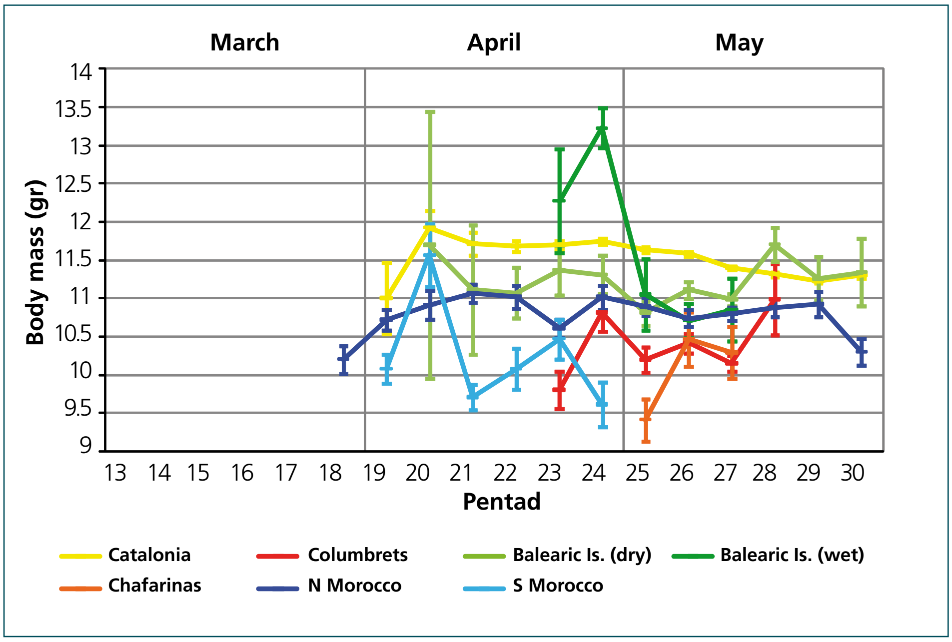
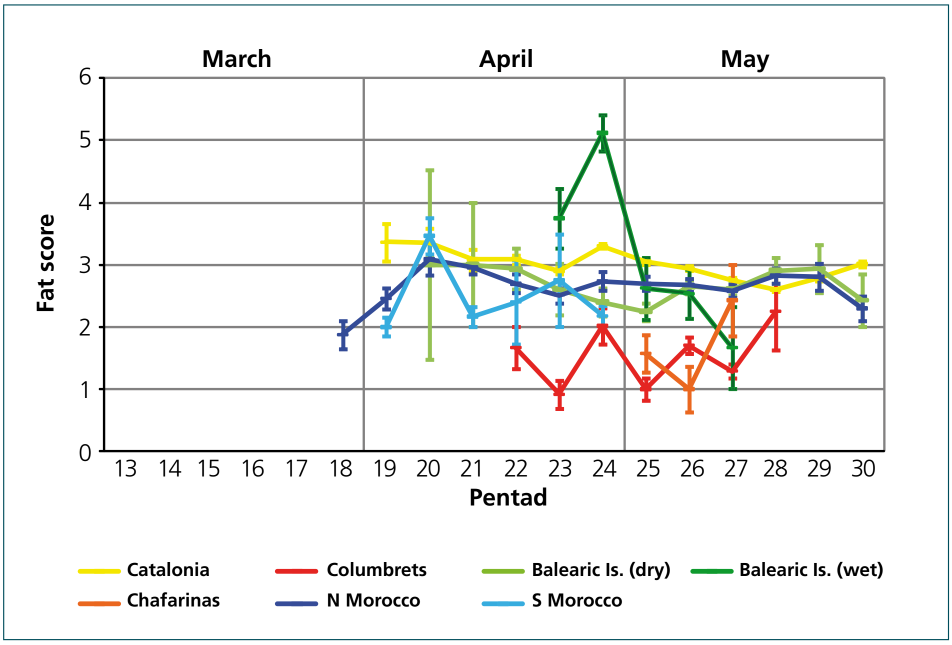


Figure 9. Temporal variation in fat score according to area.



Great Reed Warbler
Acrocephalus arundinaceus

Germán López-Iborra & Joan Castany

Range

This species' huge breeding range extends from SW Europe eastwards to the Pacific coast of Asia. The nominate race breeds patchily in NW Africa, but widely in Europe, from the Iberian Peninsula and France east to the Caspian Sea, and north to southern Scandinavia (Cramp, 1992). The nominate race winters south of Sahara, from Sierra Leone to southern Ethiopia and South Africa (Del Hoyo et al., 2006) and exhibits strong natal and breeding philopatry (Hansson et al., 2002). Regarding the study sites, it breeds in all Catalan and Balearic wetlands and at Larache (N Morocco), but even there the vast majority of captures are of non-local migrants.

Migratory route

Few recoveries of the species are direct, although most show a clear SW-NE orientation, connecting the study area with its C and NE European breeding areas (fig. 1). Flight directions of birds from Els Columbrets/Balearic Islands and continental Spain are similar, although those from the islands tend to originate from a narrower southern range of latitudes (mostly northern Italy and Czech Republic), while those from the Iberian Peninsula come from further north (northern Germany to southern Sweden). This suggests some differentiation in the origins of individuals migrating through the study area, although the sample size is too small to be conclusive.

Connectivity areas in Central and NE Europe are similar to those reported in birds trapped in spring in Italy, mostly on the Tyrrhenian coast (Spina & Volponi, 2009). Therefore, these populations may return to breeding grounds either using a more continental and lengthy route through Morocco and Spain, or a more direct one crossing the Mediterranean and continuing up the Italian peninsula. Interestingly, birds crossing the Tyrrhenian islands are larger (mean 74.5, n = 61; Spina et al., 1993) than in Catalonia and the dry Balearics, but their body mass and physical condition are 9% and 14% lower than in Catalonia and 4% and 12% lower than in dry Balearics.

The scarcity of captures in the dry Balearics and Els Columbrets is notable (fig. 2), although the fact that this species is nearly always captured in wetlands indicates a strong selection of reed beds or similar vegetation types on stopovers during migration.

Phenology

The first birds are captured at the end of March and then the frequency increases steadily from mid-April to a peak in the first half of May (fig. 3). Numbers remain high until the end of May. The low proportion of breeding birds in the dataset implies that passage continues well into early June. Birds captured during the first half of May are ringed/recovered distinctly further north than birds trapped earlier, suggesting that later birds could belong to more northerly populations. The main passage is similar in Catalonia and the Balearic Islands/Els Columbrets, but *c.* 1-2 weeks earlier in N Morocco and, apparently, somewhat earlier also in Malta (mostly mid-April to mid-May; Sultana & Gauci, 1982). In accordance with findings presented here, published data from Morocco show that birds usually arrive there from early March onwards, but that the main passage period peaks in mid-April to mid-May (Thévenot et al., 2003; Gargallo et al., unpubl.).

Biometry and physical condition

Mean third primary length ranges from 72.4 in dry Balearics to 74.1 in wet Balearics (table 1), slightly shorter than measurements reported in the C Mediterranean (mean 74.5, n = 61; Spina et al., 1993). Mean values of wing length vary between 93.8 in N Morocco and 97.4 in Columbrets, and are within the range reported elsewhere in W Europe (Cramp, 1992). Mean body mass varies from 25.5 in Els Columbrets to 31.6 in wet Balearics, while mean fat score is most often between 2 and 3. Birds trapped in wet Balearics have the highest average body mass, while those from N Morocco and Catalonia are significantly heavier than in the dry Balearics and, noticeably, Els Columbrets (fig. 8, table 1). Identical results are found for physical condition (fig. 7). Mean fat does not differ statistically between Catalonia, Els Columbrets and the dry Balearics, where birds have significantly less fat than in the wet Balearics; in N Morocco birds attain the maximum average (fig. 9).

Third primary length decreases with a similar gradient in all localities, reflecting the earlier passage of males (of larger size; Cramp, 1992), and has a significantly lower average in N Morocco (fig. 6, table 1). There is no clear temporal trend in fat score and physical condition, but body mass tends to decrease slightly (figs. 7-9). Average body mass of birds captured in N Morocco is *c.* 9% above that reported for SE Morocco (27.1, n = 24; Ash, 1969; Gargallo et al., unpubl.) and mean fat is also higher (mean in SE Morocco 2.9, n = 12; Gargallo et al., unpubl.), suggesting birds use the former area to regain energetic reserves after crossing the Sahara and in preparation for reaching Europe. This view is further supported by stopover data (see below) and the fact that while the species largely overflies NW Africa in autumn, it is much more common or at least regular there in spring (Cramp, 1992; Isenmann & Moali, 2000; Thévenot et al., 2003; Isenmann et al., 2005). Once in Europe, birds seem to be able to regain some mass along the route. Body mass in Catalonia is very similar to N Morocco (although fat and physical condition are lightly lower) and further north in S France and Fair Isle (Scotland) reported averages are even slightly higher than in Catalonia (means 30.9 [n = 6] and 31.6 [n = 4], respectively; Cramp, 1992).

On the other hand, in the dry Balearics and on Els Columbrets body condition is distinctly lower than in continental NE Spain and N Morocco and even lower than in birds trapped in W Europe during the breeding season (means *c.* 28.1-30.1; Cramp 1992; ICO, 2010), indicating that the sea-crossing is very demanding. A markedly different situation is encountered in the wet Balearics, where birds are in distinctly better condition, even in comparison to Catalonia. These vital wetlands are the only suitable habitat for the species in these islands and may therefore allow higher mass gains than the other areas. Moreover, being located on larger islands can involve a smaller proportion of recently landed birds and of birds in poor condition needing to stop at the first available site, all these factors positively influence body condition. The higher body mass in comparison to Catalonia may reflect the fact that birds trapped in these insular wetlands hurry to gain weight so as to be able to finish their sea-crossing.

Stopover

Data on stopovers are very scarce except in mainland Catalonia (fig. 5, table 2). The proportion of retrapped birds is highest in Catalonia and N Morocco, the only sites where fuel deposition rates are significantly positive (moreover in Catalonia retrapped birds have significantly higher masses when last captured). The minimum stopover duration is also higher in these areas, but differences only significant between Catalonia and the wet Balearics. In the dry Balearics retrapped birds tend to be lighter than birds that are not retrapped (contrary to the situation observed in the wet Balearics), suggesting that in general individuals in worse condition stay for several days in these areas; the sample size, however, is very small and differences are not significant. Data from Catalonia and N Morocco may include a few breeding birds; however, the fact that retraps show positive fuel deposition rates and that nesting birds are a minority suggest that these results are representative of migrants.

Overall, data support the role of N Morocco as a relevant stopover site and indicate that birds migrate through continental Spain maintaining their energetic balances and even increasing somewhat in mass. Retraps are strikingly low in the wet Balearics. This may indicate that the higher body mass in this area are more a reflection of the scarcity of birds forced to land due to poorer condition than to extended stays (in fact only 3% of birds in the wet Balearics have body masses below 25 g, but as many as 30% in the dry Balearics). However, a lack of retraps does not rule out the possibility that a certain number of birds trapped in these wetlands had already been on these bigger islands for a few days, but not necessarily at the ringing site.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	1,062	95.1 ± 3.1 (86.0-103.3)	73.1 ± 2.7 (65.5-80.0)	29.4 ± 2.8 (17.6-39.8)	2.3 ± 1.3 (0-8)
Columbrets	5	97.4 ± 4.9 (90.5-102.0)	73.9 ± 2.9 (72.0-79.0)	25.5 ± 3.5 (21.2-32.2)	1.1 ± 1.7 (0-4)
Balearics (dry)	59	93.9 ± 3.1 (88.0-100.5)	72.4 ± 2.8 (66.0-77.5)	27.8 ± 4.3 (19.3-39.2)	2.2 ± 1.6 (0-6)
Balearics (wet)	60	96.3 ± 3.0 (87.5-101.5)	74.1 ± 2.3 (69.0-78.0)	31.6 ± 4.0 (22.5-40.1)	3.3 ± 1.6 (0-6)
Chafarinas	0				
N Morocco	82	93.8 ± 3.6 (83.0-104.0)	72.5 ± 2.7 (66.5-79.5)	29.8 ± 4.3 (22.3-45.7)	3.6 ± 1.4 (0-7)
S Morocco	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	0.30 ± 0.13 (169)		0.43 ± 0.83 (2)	0.90 ± 1.47 (2)		0.73 ± 0.46 (7)
Retraps >1 day	0.36 ± 0.11 (134)		0.43 ± 0.83 (2)	0.90 ± 1.47 (2)		0.70 ± 0.54 (6)

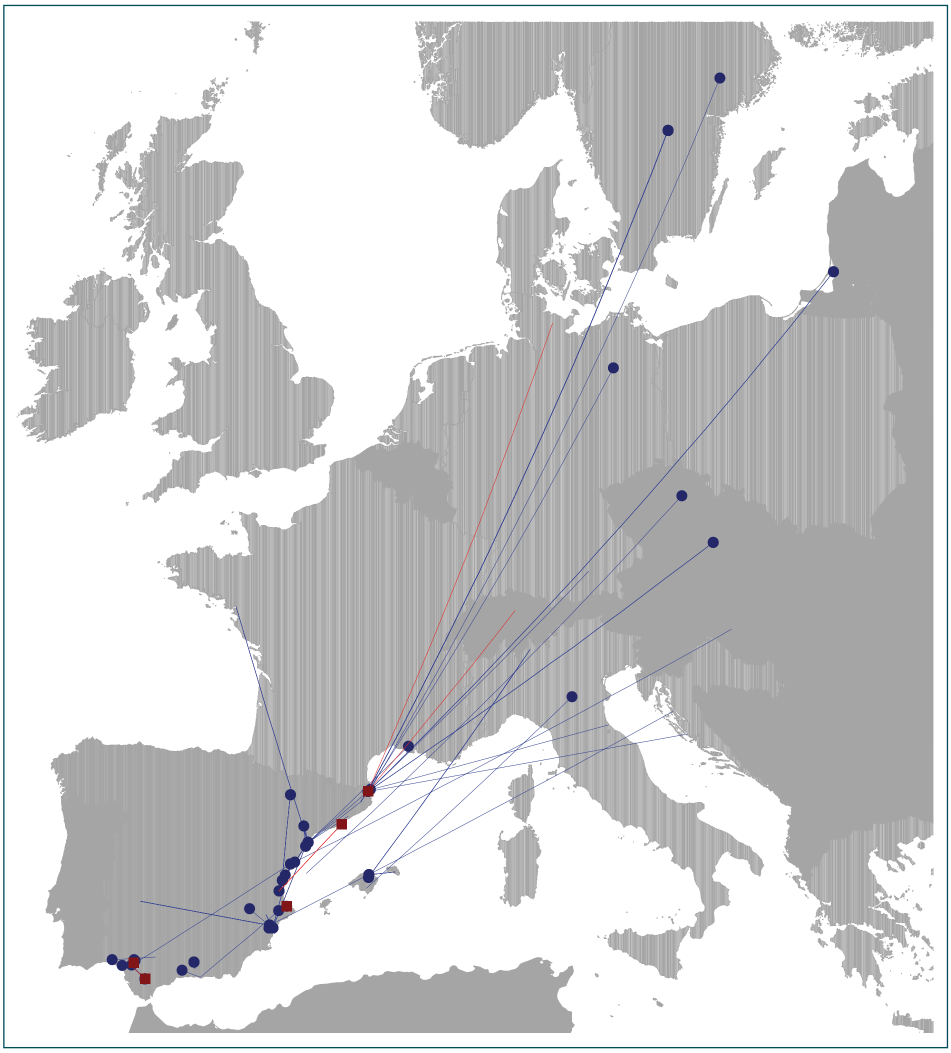


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

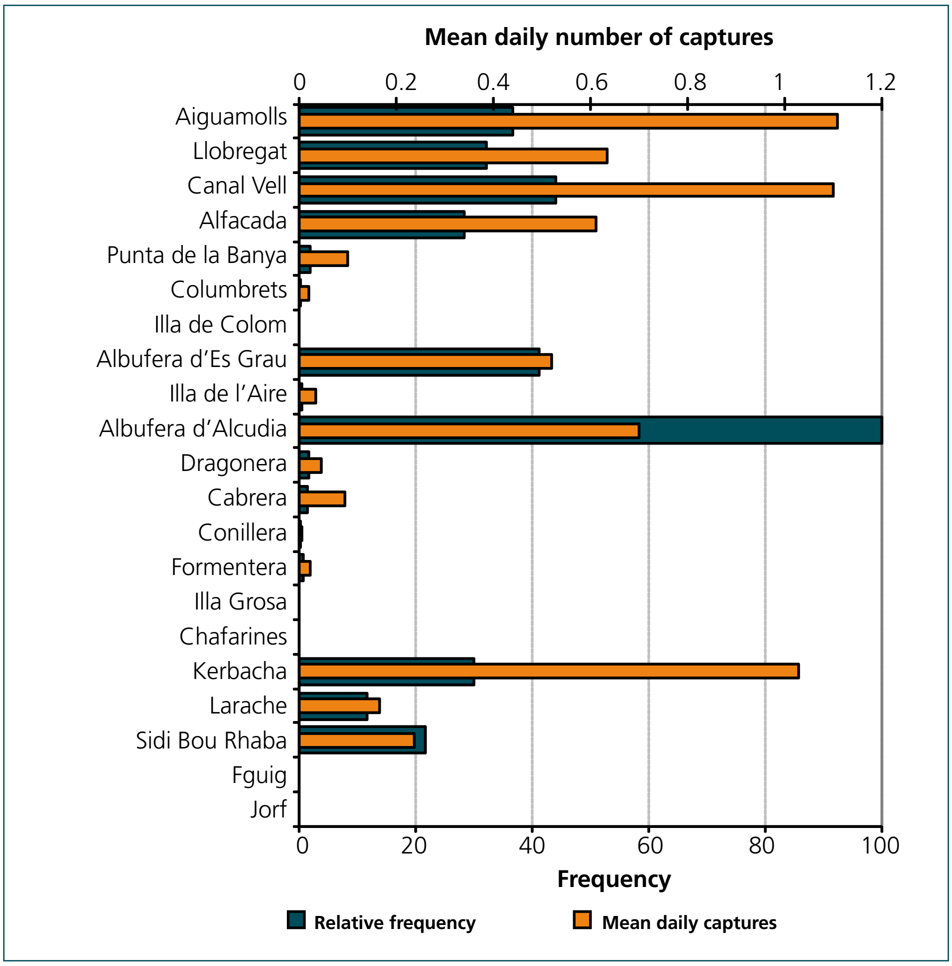


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

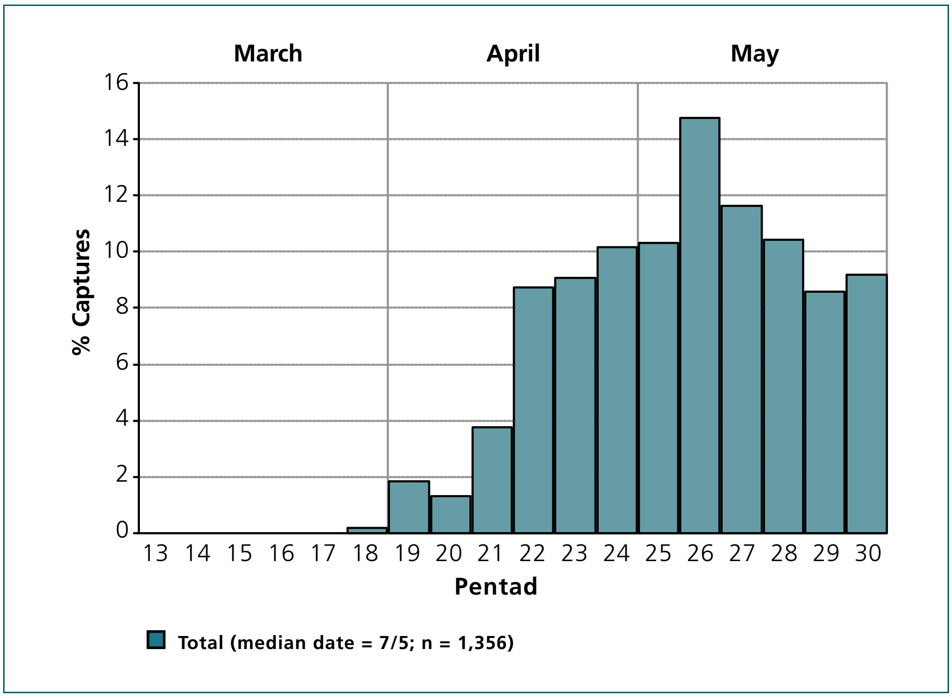


Figure 3. Frequency of captures during the study period.

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

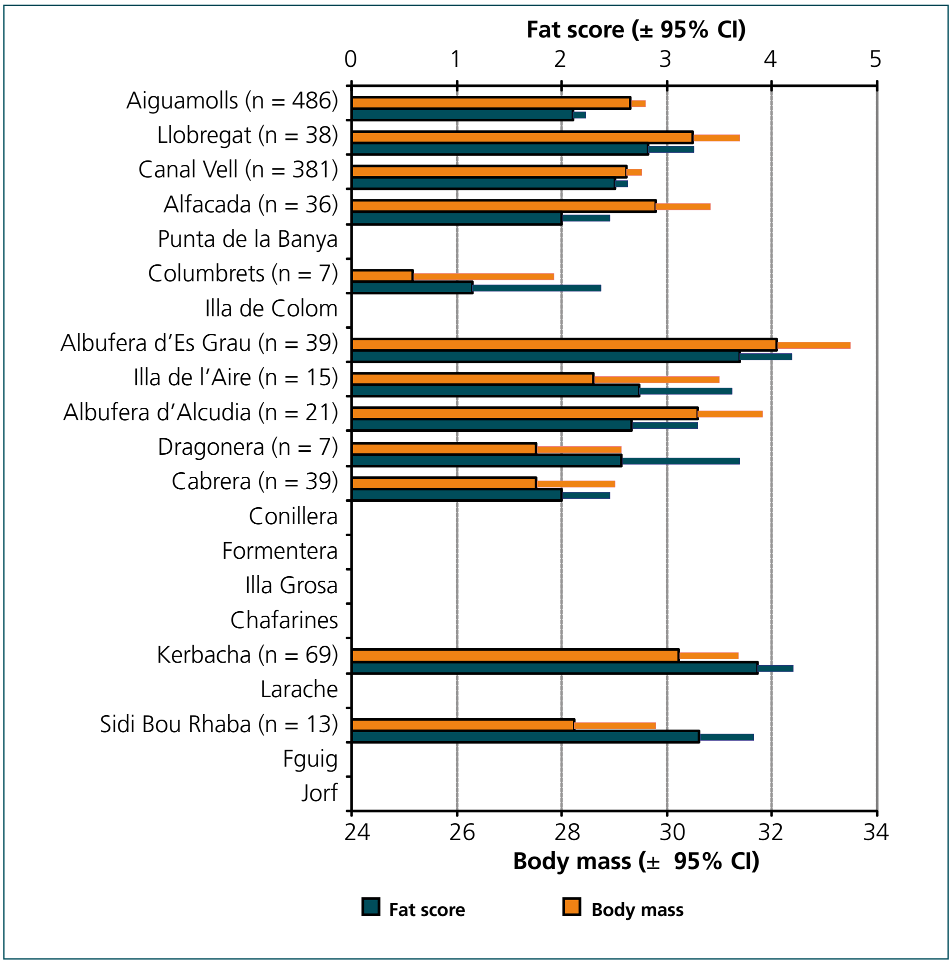
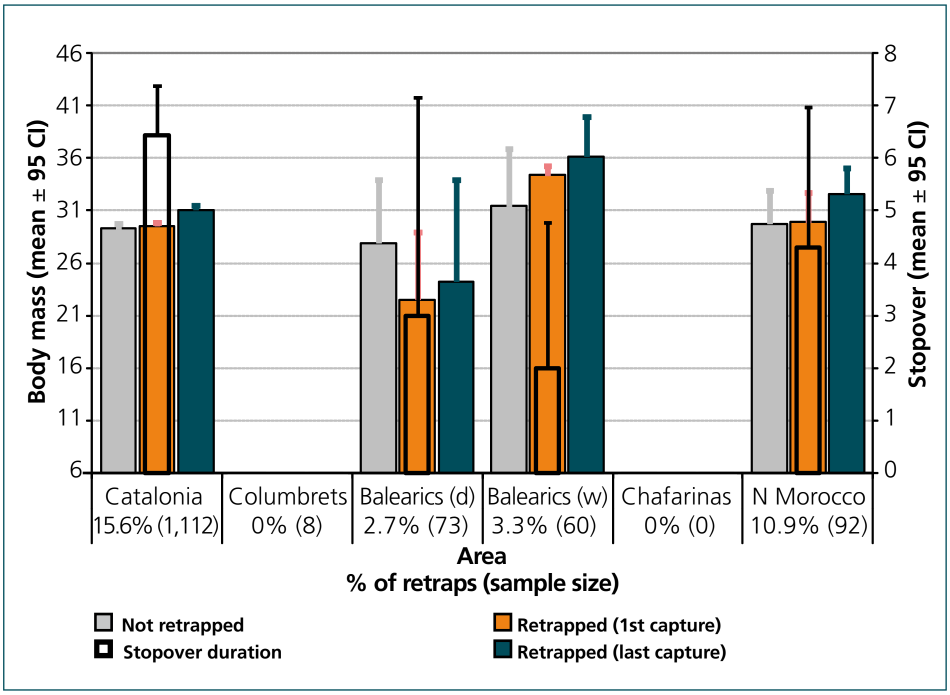


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



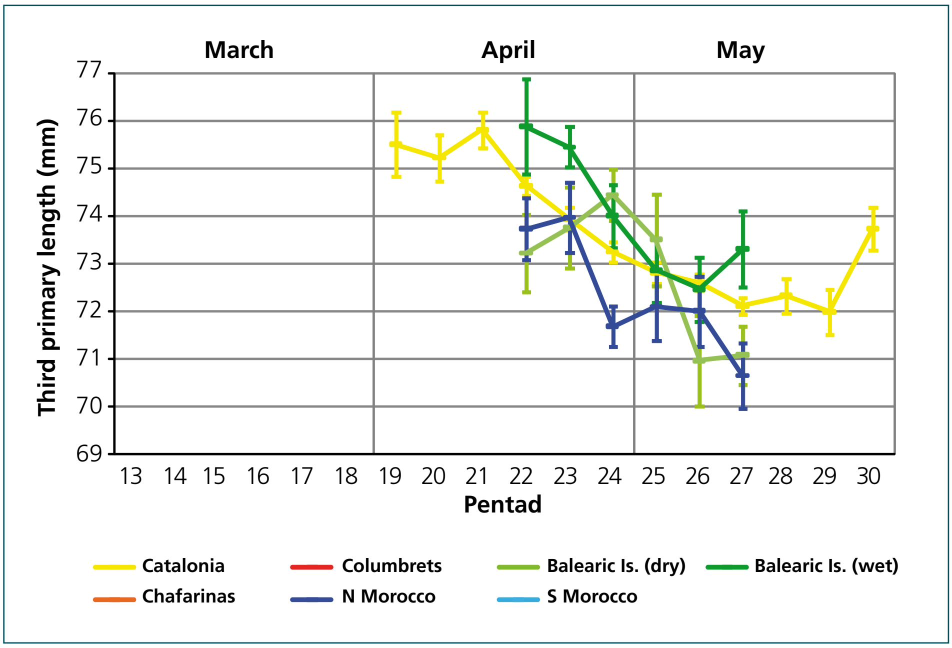


Figure 6. Temporal variation of third primary length according to area.

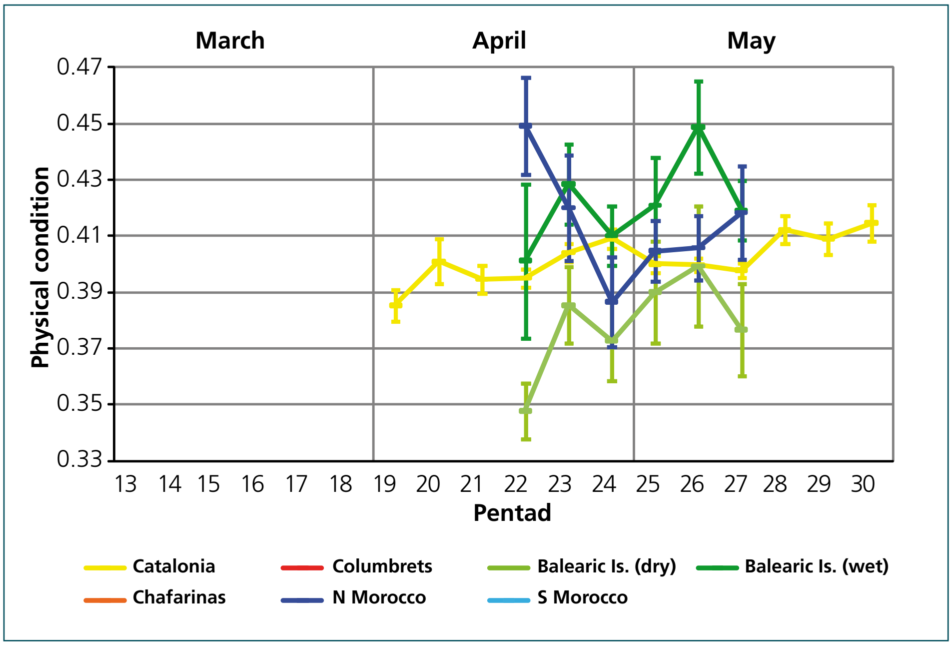


Figure 7. Temporal variation of physical condition according to area.

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

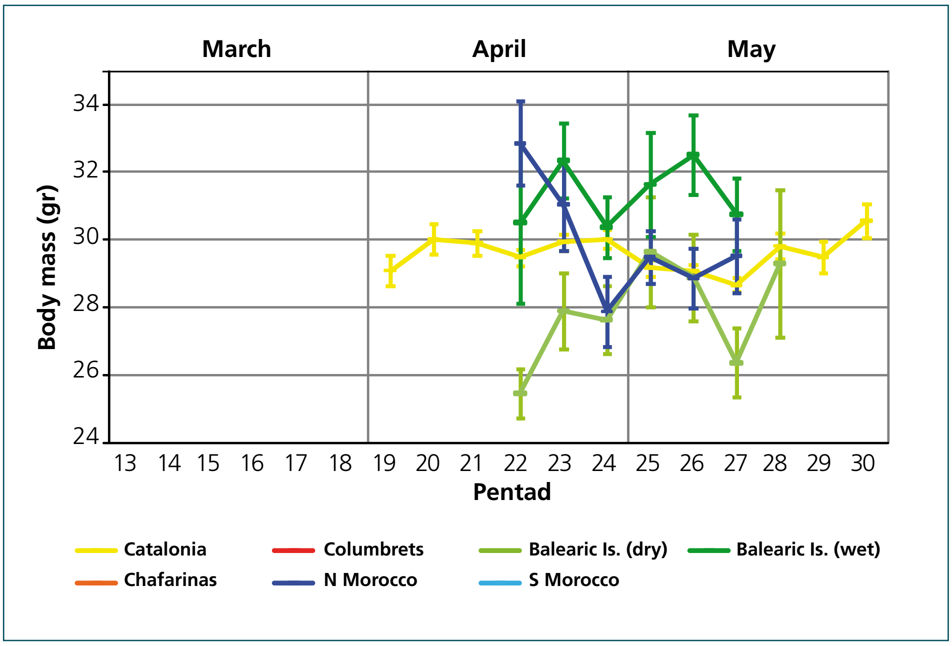
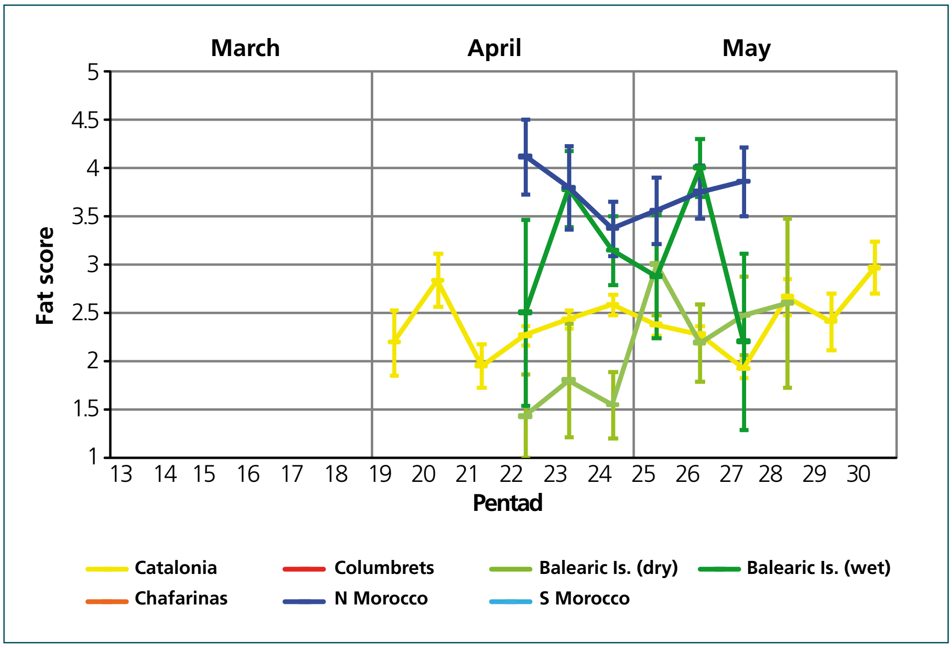


Figure 9. Temporal variation in fat score according to area.



Icterine Warbler

Hippolais icterina

Pere Garcias

Range

The Icterine Warbler breeds in temperate and boreal regions in middle and upper latitudes of the W Palearctic, from NW France north to Scandinavia and east to *c.* 85ºE (Cramp, 1992; Bairlein et al., 2006). It winters in sub-Saharan Africa south of the equator (Moreau, 1972; Cramp, 1992) and is considered a rare migrant along the Iberian Mediterranean coast, but more regular in the Balearics (Costa, 1990; Garcias, 1992; Tellería et al., 1999). It does not breed in either Spain or Morocco.

Migratory route

The geographical variation in the frequency of captures indicates that this species is more abundant to the east, being particularly common in the Balearic Islands, especially in eastern sites such as Cabrera and L'Illa de l'Aire (fig. 2). In Morocco this species is concentrated in the extreme NE of the country, where numbers are low but seemingly regular. Our data agree with the known migratory behavior of this species, which reaches breeding grounds along a due S-N or S-NNW trajectory that generally crosses the central Mediterranean (Pettersson et al., 1990; Spina et al., 1993; Pilastro et al., 1998). In spring, migration takes place along a more westerly route than in autumn (Moreau, 1972; Cramp, 1992), explaining the higher frequency of spring records in the W Mediterranean (Cramp, 1992; Tellería et al., 1999; Thévenot et al., 2003; ICO, 2010).

The only available recovery refers to an interesting record of a bird ringed on Cabrera (Balearics) in May 1992 and recovered in May 1994 on another island along the S Tyrrhenian coast in Italy, which suggests that the spring migratory route can vary widely from year to year.

Phenology

Migration starts during the second half of April with a small number of captures and then rises quickly to a peak in mid-May (fig. 3). The relatively high number of captures at the end of the study period indicates that passage still continues relatively abundantly into early June. Overall, the pattern is similar to that already reported for SW Europe and NW Africa (Blondel & Isenmann, 1981; Cramp, 1992; Spina et al., 1993; Tellería et al., 1999; Thévenot et al., 2003; Isenmann et al., 2005). The median date of passage is similar to that reported for the C Mediterranean (Spina et al., 1993; Pettersson et al., 1990).

Biometry and physical condition

Mean values for third primary lengths range from 60.0 in N Morocco to 61.4 in Catalonia, very similar to the values reported in the C Mediterranean (61.3, n = 515; Spina et al. 1993; table 1). Mean values for wing lengths vary from 77.4 in N Morocco to 79.2 in Els Columbrets, within the range reported from other parts of Europe (Cramp, 1992). Third primary length tends to decrease with time, probably due to the later passage of females (females are shorter winged and are known to reach breeding grounds later than males; Cramp, 1992; fig. 6). In the C Mediterranean, third primary values increase with time at some sites and decrease at others (Spina et al., 1993).

Mean fat score values range from 0.7 on Els Columbrets to 3.8 in N Morocco (table 1). Mean body mass varies from 11.5 to 14.2-14.6, again with the lowest values on Els Columbrets, while the highest values are from the few birds trapped in N Morocco and the wet Balearics. Physical condition is higher in N Morocco than in Catalonia; birds from the dry Balearics have similar figures to those from Catalonia but significantly higher than on Els Columbrets (fig. 8). The very few birds trapped in the wet Balearics are in distinctly better condition than those from the dry Balearics (table 1), in terms of both body mass and fat reserves and physical condition. Mean body mass in the dry Balearics and on Els Columbrets are similar to that reported in the C Mediterranean (mean 12.0, n = 515; Spina et al., 1993). In N Morocco mean body mass is significantly higher than in the other areas (except wet Balearics), and is also higher than those reported for N Tunisia (mean 13.4, n = 21; Waldeström et al., 2004). Available data from S Morocco indicates that birds arrive there with lower body mass and fat reserves (mean 11.4 and 2.8 respectively, n = 9; Gargallo et al., unpubl.), suggesting that birds regain substantial energetic reserves in N Morocco and, apparently, in N Tunisia as well. The fact that this warbler is much commoner in NW Africa in spring than in autumn (Zink, 1973; Cramp, 1992; Thévenot et al., 2003; Isenmann et al., 2005) further supports this view of this area as a reliable stopover site.

Globally, fat score, body mass and condition index show a slight but significant increase during the course of the migration period (figs. 7-9), suggesting that later on in the season more birds are in less of a hurry to migrate faster, or that environmental conditions encountered en route and/or in tropical Africa are better.

Stopover

Retraps are globally low but more frequent in Catalonia than in the dry Balearics or on Els Columbrets, suggesting that birds specifically avoid to stay in more isolated areas with unsuitable habitat (fig. 5, table 2). Otherwise, there are no significant differences in terms of body mass or stopover length, probably due to the very small sample sizes.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	47	79.0 ± 2.0 (74.0-83.5)	61.4 ± 1.5 (57.0-64.0)	12.8 ± 1.2 (10.0-16.0)	2.5 ± 1.2 (0-6)
Columbrets	27	79.2 ± 2.2 (73.0-82.5)	60.9 ± 1.8 (58.0-65.5)	11.5 ± 1.5 (9.2-14.7)	0.7 ± 0.8 (0-3)
Balearics (dry)	379	78.8 ± 2.0 (73.0-83.5)	61.1 ± 1.9 (56.0-66.0)	12.6 ± 1.4 (9.1-17.8)	2.2 ± 1.2 (0-5)
Balearics (wet)	3	78.8 ± 1.0 (78.0-80.0)	61.0 ± 1.3 (60.0-62.5)	14.6 ± 0.6 (14.1-15.2)	3.0 ± 0.0 (3-3)
Chafarinas	1		60.0	12.5	2.0
N Morocco	10	77.4 ± 2.4 (75.0-81.0)	60.0 ± 2.2 (57.5-63.5)	14.2 ± 1.5 (11.8-16.1)	3.8 ± 1.3 (1-6)
S Morocco	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	0.26 ± 0.43 (5)		-0.07 ± 0.19 (22)			
Retraps >1 day	0.06 ± 0.22 (3)		0.06 ± 0.17 (13)			

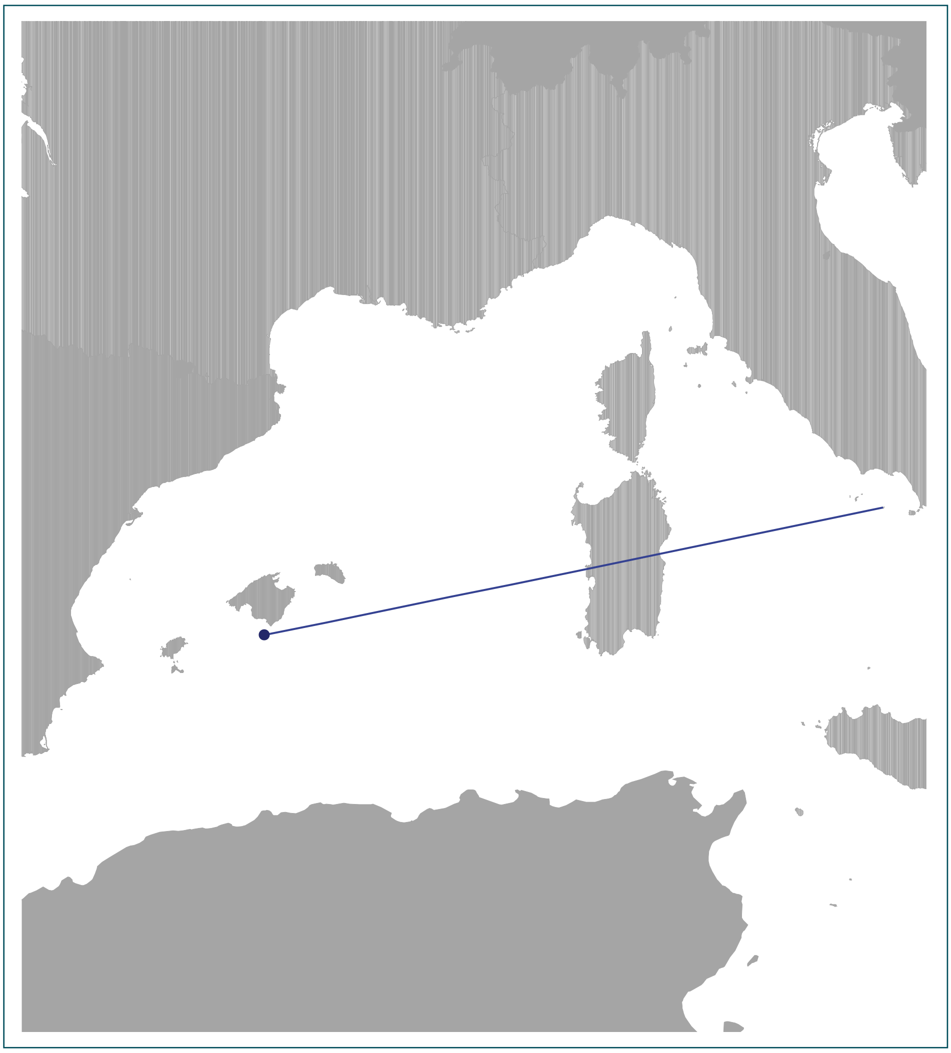


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

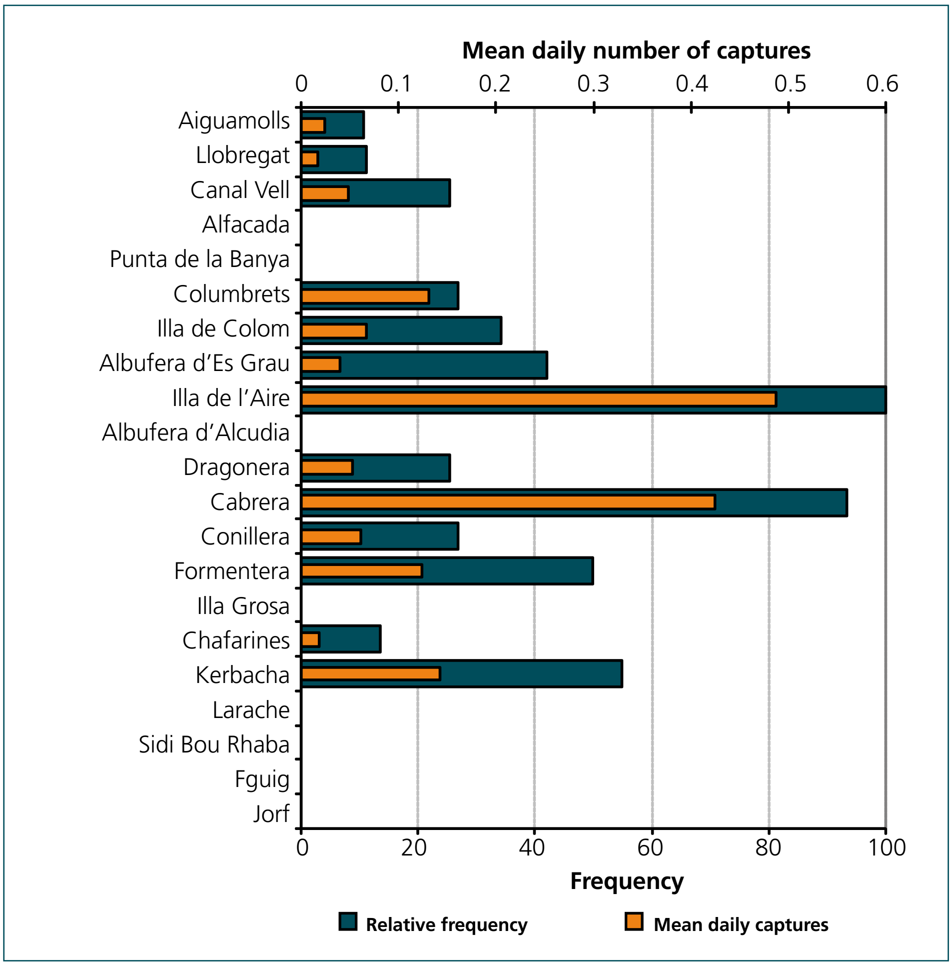


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

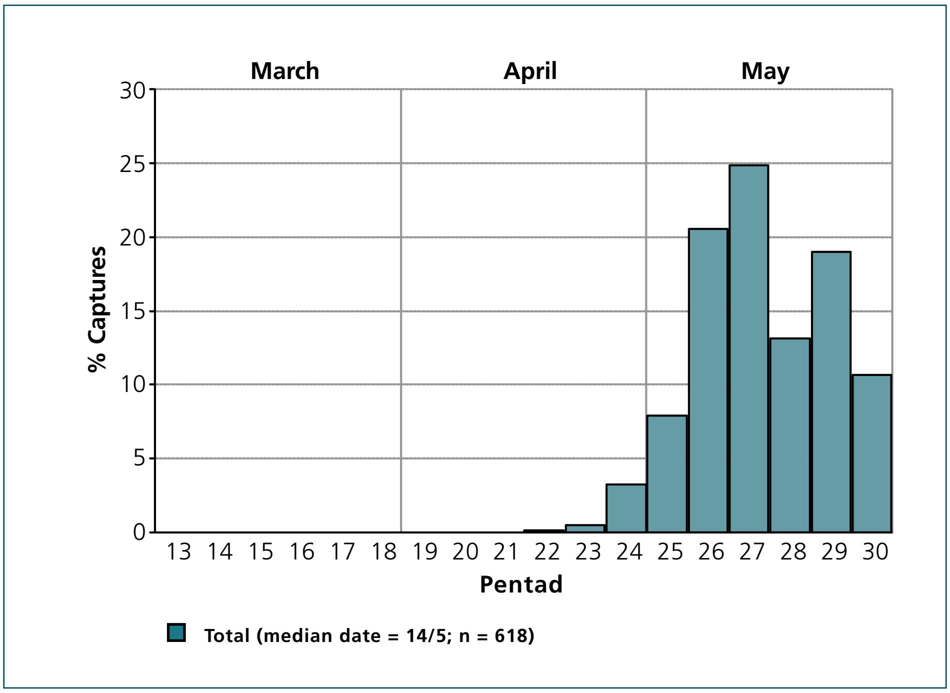


Figure 3. Frequency of captures during the study period.

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

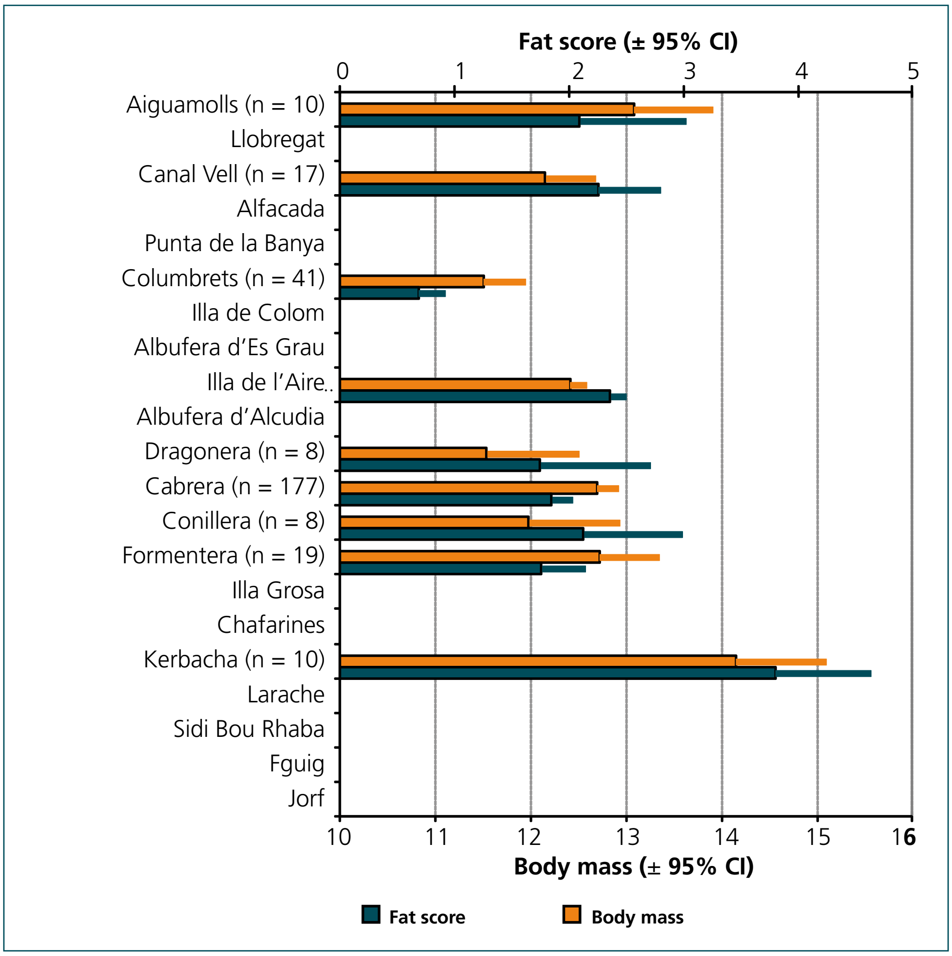
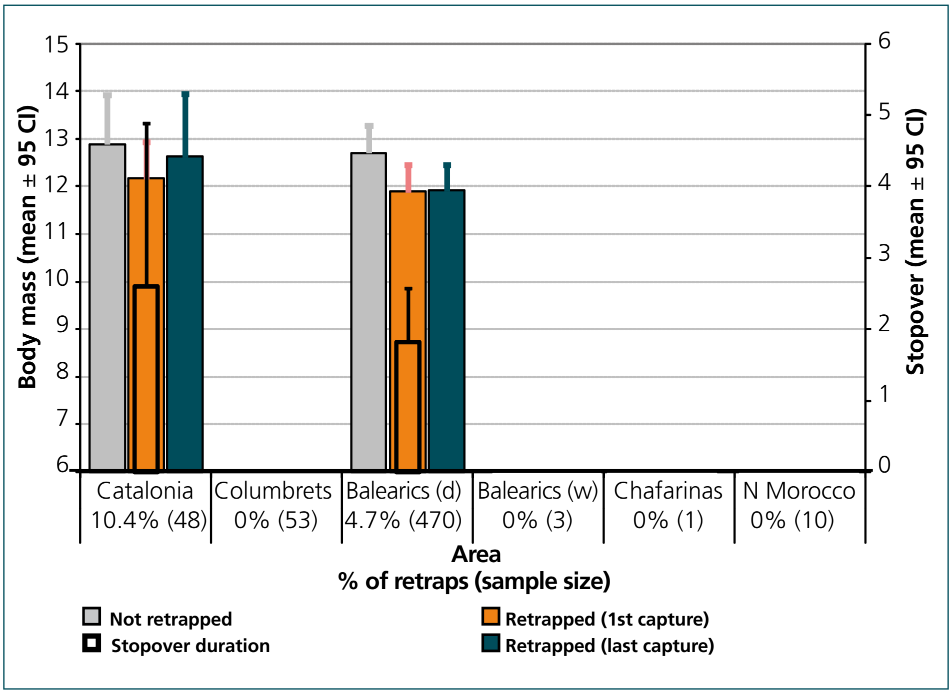


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



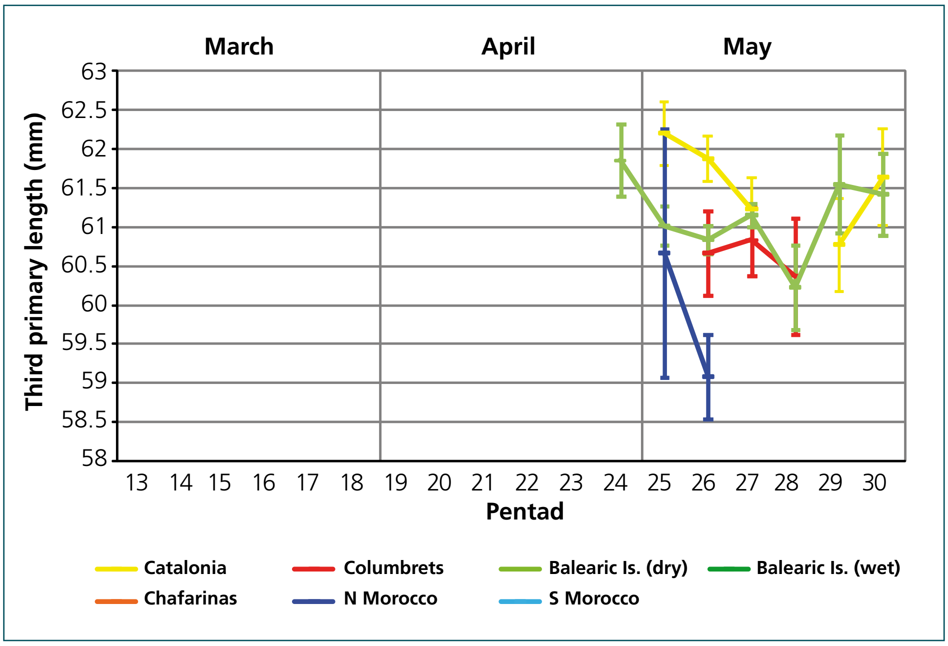


Figure 6. Temporal variation of third primary length according to area.

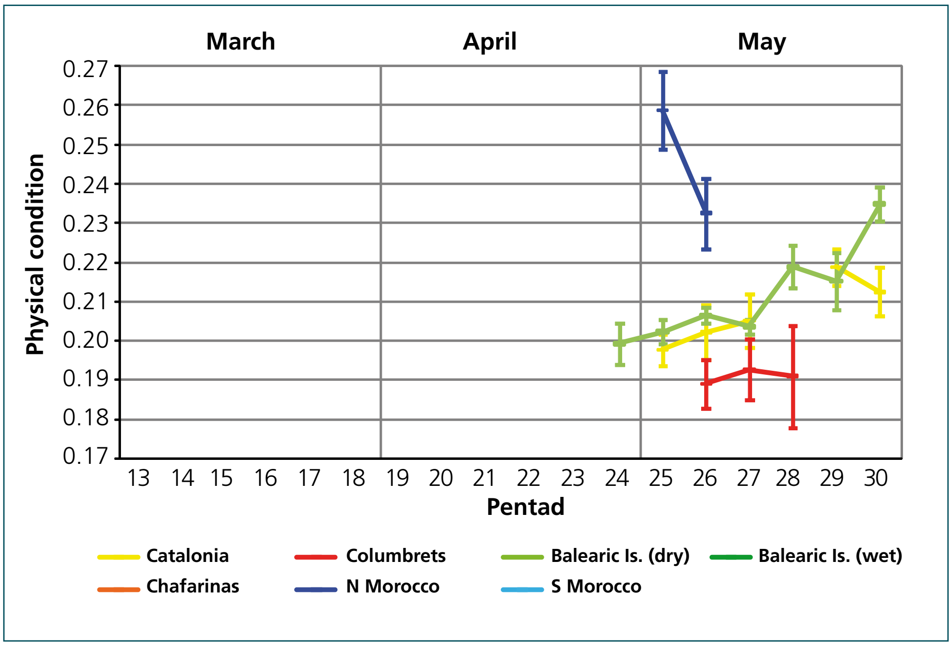


Figure 7. Temporal variation of physical condition according to area.

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

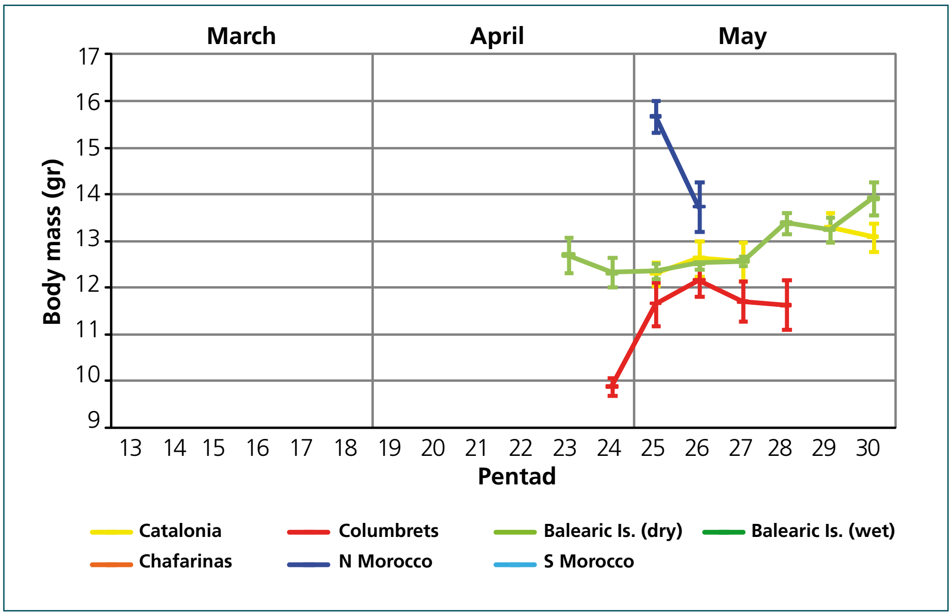
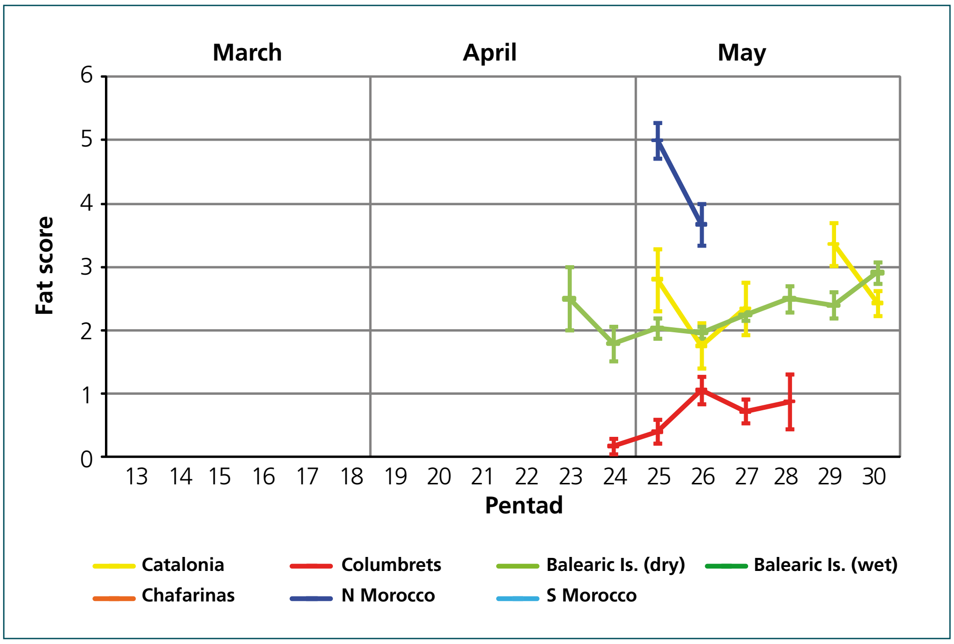


Figure 9. Temporal variation in fat score according to area.



Melodious Warbler

Hippolais polyglotta

José Manuel Igual

Range

The Melodious Warbler is a monotypic species that breeds in NW Africa and SW Europe (Cramp, 1992). In all, 90% of its European population breeds in the Iberian Peninsula, France and Italy (BirdLife International, 2004) and since the mid-1930s its populations have increased in range on the NW borders of their distribution (Hagemeiger & Blair, 1997). It winters in W Africa, roughly between 5 and 10ºN, from Gambia, Sierra Leone and Senegal east to Nigeria and Cameroon (Cramp, 1992). It does not breed on the Balearic Islands (Bermejo & De la Puente, 2003) and, of the ringing sites, it only breeds in very low numbers at Els Aiguamolls.

Migratory route

Recoveries, although scarce, reveal a SW to NE passage across the Iberian Peninsula towards the species' northern breeding ranges, as well as the existence of movements due eastwards along the N Mediterranean coast (one bird ringed in NE Spain in late April and trapped 18 days later in N Italy; fig. 1). An individual ringed in Mallorca in early May was recovered in N Morocco seven days later, showing a curious case of reverse migration. Moreover, there is a spring recovery in Morocco of a bird ringed in Italy in May of the preceding year (Spina & Volponi, 2009).

The geographical variation in the frequency of captures indicates that this species is very common along the Spanish Mediterranean coast (it is abundant in spring in the area of the Straits of Gibraltar; Finlayson,1992) and, especially, in NW Morocco; captures, though, are scarce on the Balearic Islands (fig. 2). Our data thus match earlier findings indicating that this species enters Europe through the SW of the Iberian Peninsula (as many other songbirds do; Hilgerloh, 1991) and then heads for the more eastern parts of range, *e.g.* Italy, along the N Mediterranean coast, thereby avoiding a direct sea-crossing (Puzzanghera, 1991; Pilastro et al., 1998). This pattern contrast with that found in warblers with a more easterly breeding range (*e.g.* the Icterine Warbler), which reach Europe from the SE (Spina et al., 1993; Pilastro et al., 1998).

Phenology

A few birds are trapped in late March or early April, but the species' main passage takes place between mid-April and late May, peaking during the first half of May (fig. 3). Passage extends into early June (Telleria et al., 1999; Thévenot et al., 2003). Overall, the pattern is similar to that reported in other areas of the Iberian Peninsula and S France (Blondel & Isenmann, 1981; Cramp, 1992; Finlayson, 1992), although in Italy peak migration occurs a little later (Spina & Volponi, 2009) and in S Morocco *c.* 2-3 weeks earlier (Gargallo et al., unpubl.).

Biometry and physical condition

Mean values for wing lengths vary from 65.5 in N Morocco to 67.4 in S Morocco (table 1), similar to those reported elsewhere (Cramp, 1992). Mean third primary lengths range from 50.0 in the wet Balearics to 51.5 in Catalonia. There is a clear latitudinal trend in third primary lengths: birds passing through N Morocco and Las Chafarinas have the lowest values and those from Catalonia the highest. This pattern may reflect the existence of a S-N clinal trend in size (but published biometric data are inconclusive; cf. Cramp, 1992; Bermejo et al., 2002; ICO, 2010). The third primary length decreases with time in all areas (fig. 6), probably reflecting the differential migration of the sexes: males (slightly longer-winged on average; Cramp, 1992; Svensson, 1992) migrate earlier than females. Males are probably under selective pressure to arrive sooner to establish breeding territories (Bermejo et al., 2002; Rubolini et al., 2004).

The mean fat score varies between 1.4 on Els Columbrets and 3.0 in the wet Balearics, while the mean body mass varies from 10.0 on Las Chafarinas to 11.0 in Catalonia (table 1). Body mass is highest in Catalonia, although birds from N Morocco have similar physical condition and the most fat. Body mass, physical condition and fat reserves are higher in the dry Balearics than on Els Columbrets; in both insular areas physical condition and body mass are lower than in Catalonia. Birds trapped on Las Chafarinas have significantly lower body mass, fat and body condition than those from continental N Morocco. These differences are still significant when considering just Kerbacha, located only a few km south of Las Chafarinas, but not when comparing Las Chafarinas and Sidi Bou Rhaba using data from the same year (2000; no data available for Kerbacha and Las Chafarinas for the same year). Body mass, fat and physical condition increase significantly with time in the dry Balearics but decrease in Catalonia (though not significantly so for condition; figs. 7-9). Values for average body mass in Morocco, Catalonia and the Balearics are very similar to that reported from Gibraltar (mean 11.0, n = 54; Finlayson, 1981) and, at most, are slightly higher than those obtained during the breeding season in SW Europe (means ranging mostly 10.2-10.7; Cramp, 1992; Bermejo et al., 2002; ICO, 2010). Data from S Morocco are too scarce to be conclusive, although the larger datasets available from this area indicate an only slightly lower average mass (mean 10.2, n = 45; Gargallo et al., unpubl.).

Birds may gain some mass after crossing the Sahara, since average mass from S Morocco is *c.* 5% lower than in the north; however, differences between N Morocco and Catalonia are very small suggesting that birds do not fatten up in any marked way in order to reach Europe. Similar body mass across different sites in SW Europe, moreover, suggests that migration through the continent progresses in short bouts that do not require long stopovers or marked gains in mass (see below). Birds crossing large stretches of sea are subjected to higher energetic demands, as shown by the lower fat reserves and body mass and poorer physical condition of birds trapped on Els Columbrets and the Balearics, although differences with respect to N Morocco are not large (physical condition only 2-7% poorer).

Stopover

Only a minority of birds stay at the study sites (up to 8%) and largely only for very short periods of time (fig. 5, table 2). Birds from Catalonia have significant and positive fuel deposition rates (in retraps of more than one day) and undertake longer mean stopovers than those from insular areas. The few breeding birds at Els Aiguamolls may have spuriously increased mean stopover length, since at other Catalan wetlands where the species does not breed mean stopover is only 2.2 days (although the sample size is small; n = 4). In the dry Balearics and on Els Columbrets birds retrapped again tend to have lower body mass than those not retrapped, but these differences are not significant. On Las Chafarinas, in spite of the lack of suitable habitat, the fuel deposition rate is significantly positive, although not in birds staying more than one day. Overall, the present results suggest that birds do not increase body mass in any marked way during their stopovers, which are particularly short and seem to involve a higher proportion of individuals in poor body condition on isolated islands lacking suitable habitat.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	656	67.1 ± 1.8 (61.0-73.0)	51.5 ± 1.6 (46.0-57.0)	11.0 ± 0.9 (7.6-14.2)	2.2 ± 1.2 (0-6)
Columbrets	535	67.0 ± 2.2 (60.5-73.0)	51.2 ± 1.7 (46.0-57.0)	10.2 ± 0.9 (6.7-13.7)	1.4 ± 1.0 (0-6)
Balearics (dry)	735	66.3 ± 2.0 (60.0-74.0)	51.0 ± 1.8 (46.0-56.5)	10.6 ± 1.1 (6.9-14.3)	2.2 ± 1.2 (0-5)
Balearics (wet)	1	65.5	50.0	10.2	3.0
Chafarinas	390		50.2 ± 1.7 (46.0-55.0)	10.0 ± 0.9 (7.1-14.6)	1.9 ± 1.2 (0-5)
N Morocco	181	65.5 ± 2.2 (61.0-72.0)	50.1 ± 1.7 (46.0-55.0)	10.7 ± 1.1 (8.3-14.1)	2.7 ± 1.4 (0-6)
S Morocco	6	67.4 ± 1.4 (66.0-70.0)	51.3 ± 1.1 (50.0-53.0)	10.6 ± 0.6 (9.7-11.4)	2.7 ± 1.0 (1-4)

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	0.00 ± 0.12 (52)	-0.25 ± 0.32 (7)	0.06 ± 0.28 (22)		0.28 ± 0.23 (13)	-0.19 ± 0.22 (10)
Retraps >1 day	0.10 ± 0.07 (36)	-0.43 ± 0.60 (3)	-0.05 ± 0.36 (6)		0.11 ± 0.25 (7)	-0.04 ± 0.18 (5)

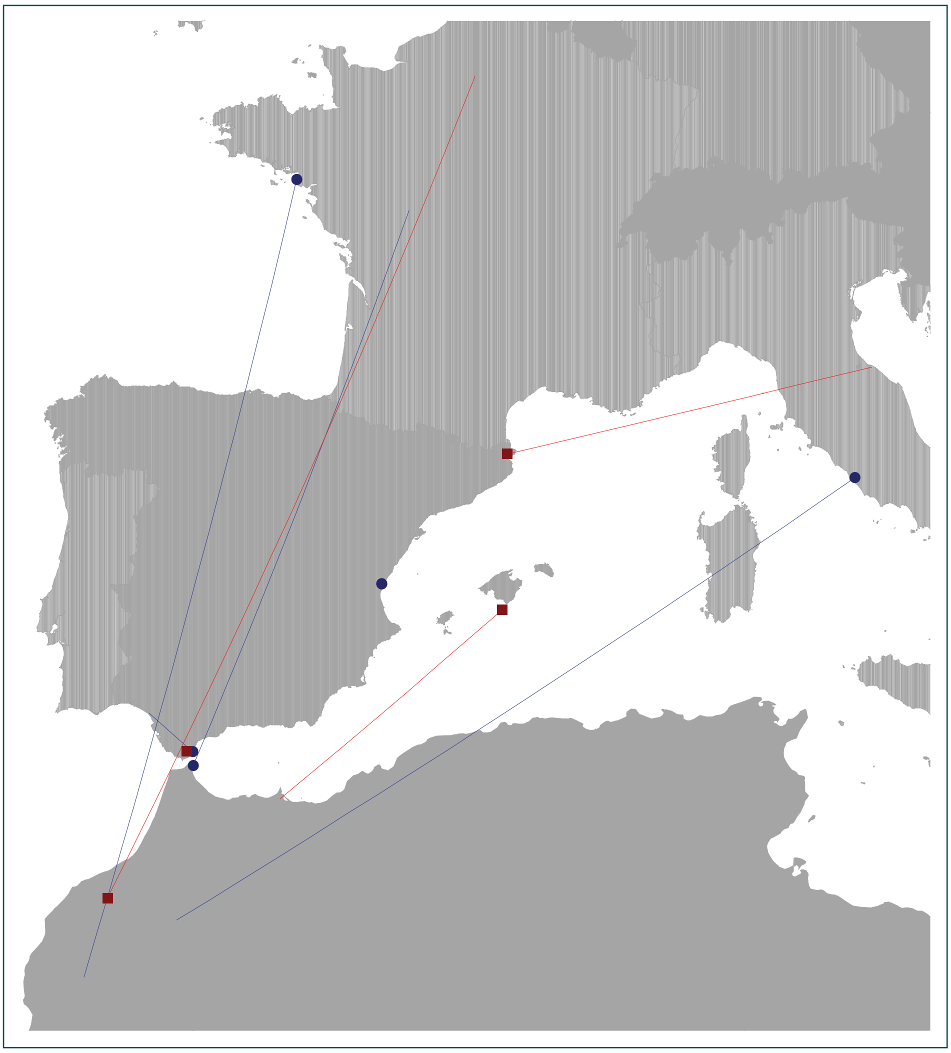


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

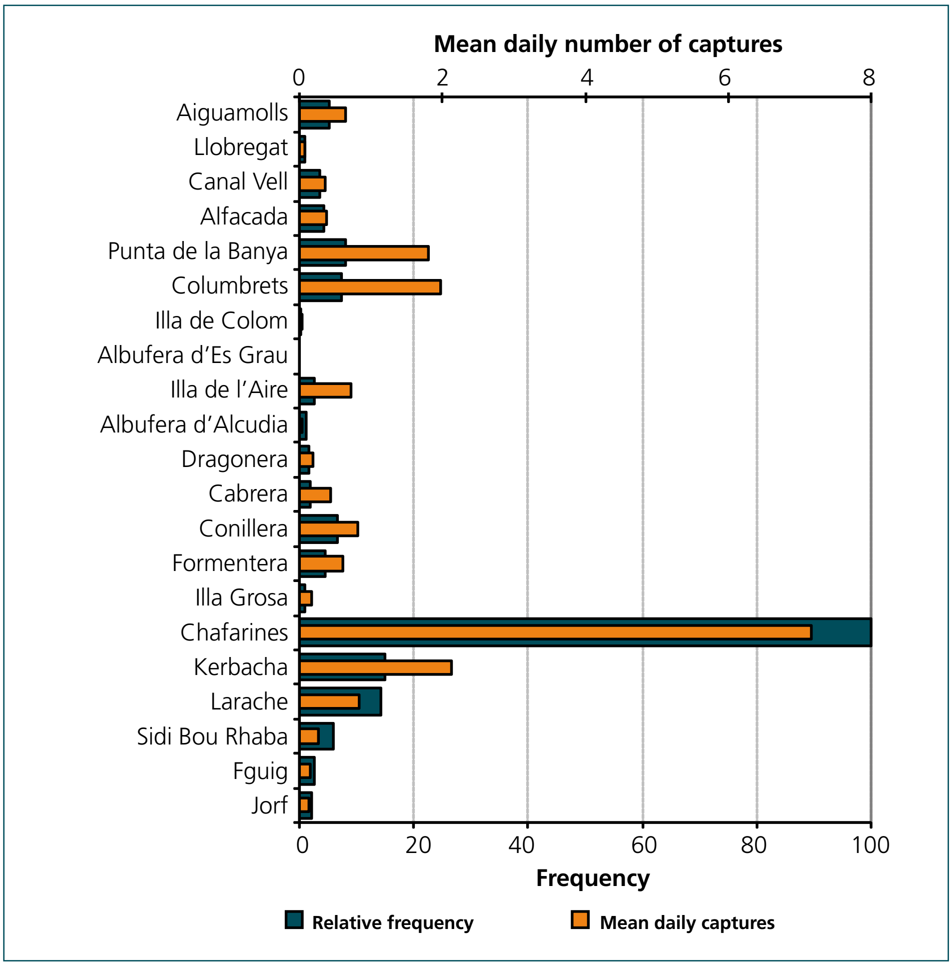


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

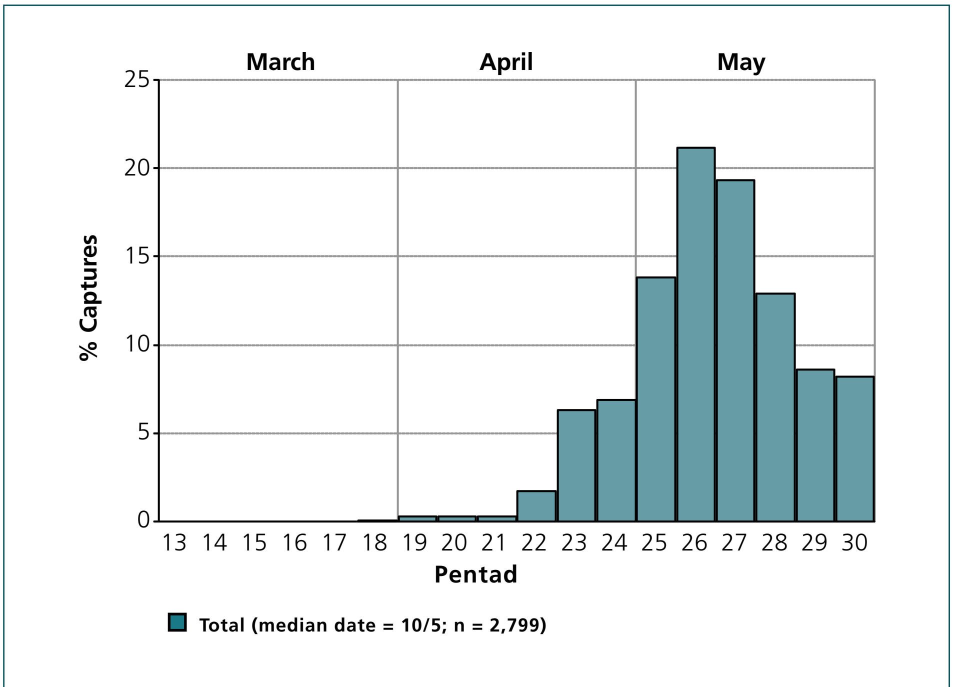


Figure 3. Frequency of captures during the study period.

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

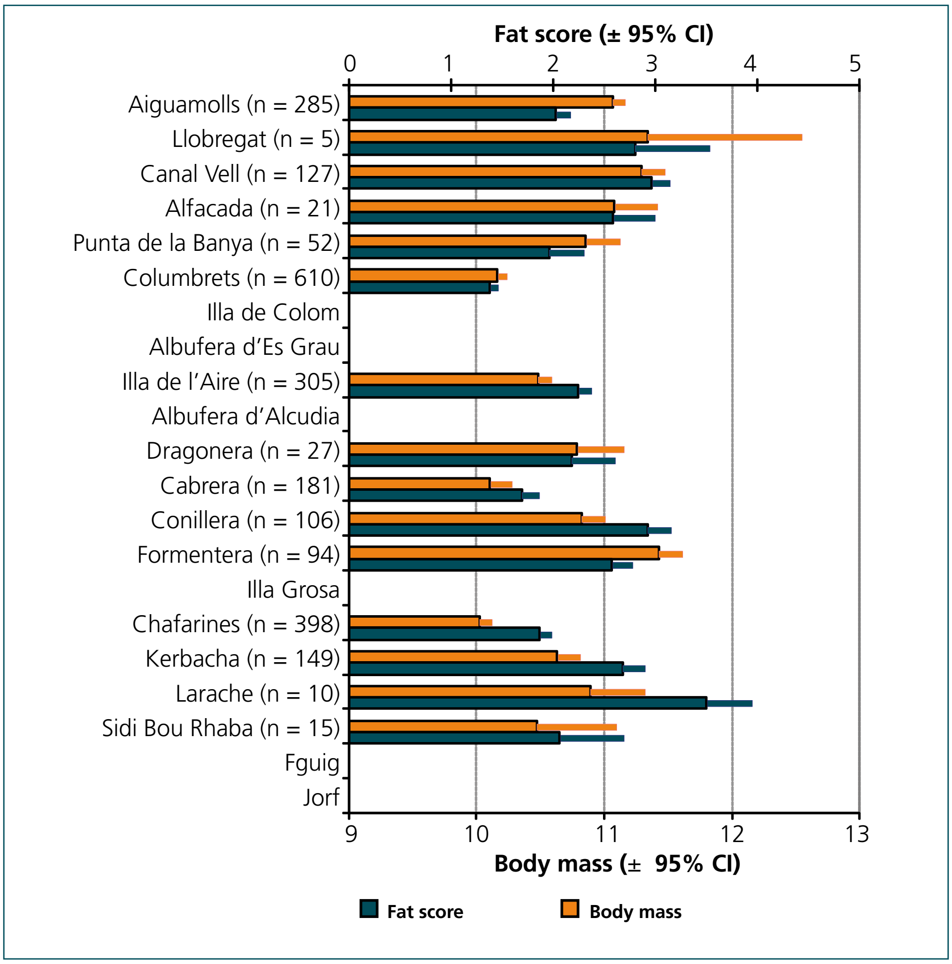
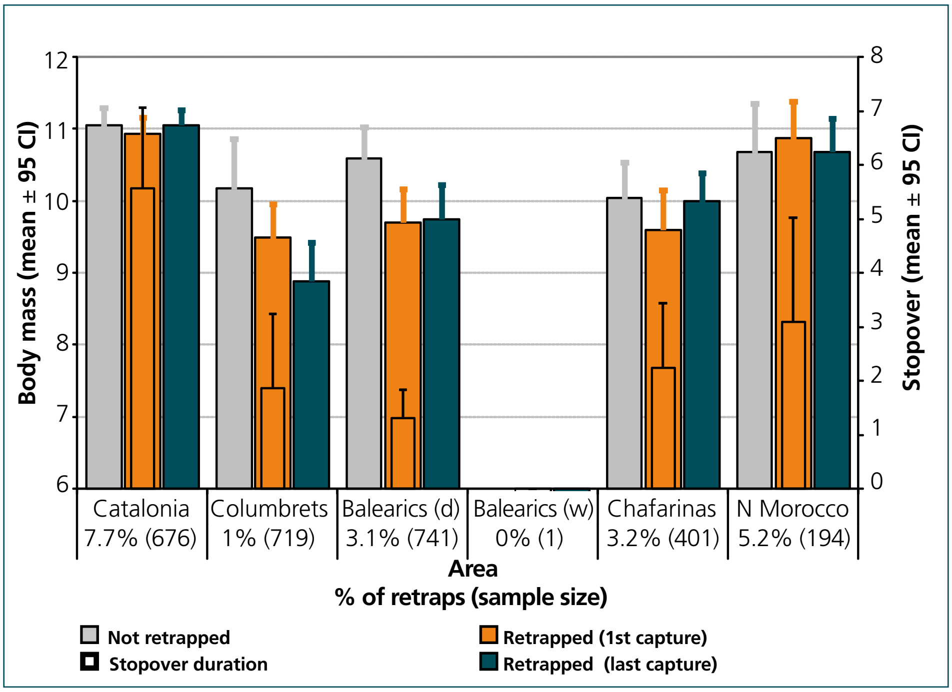


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



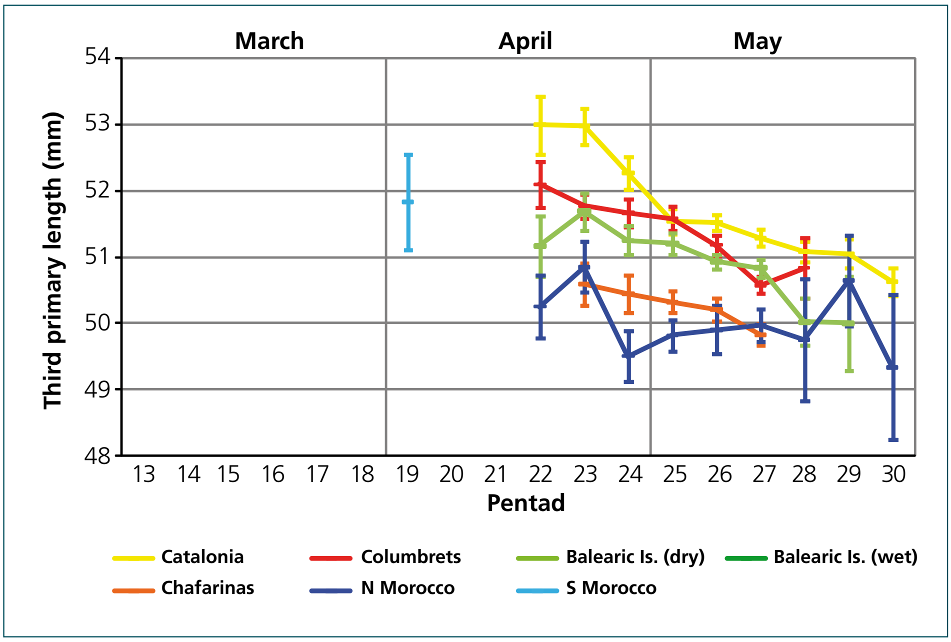


Figure 6. Temporal variation of third primary length according to area.

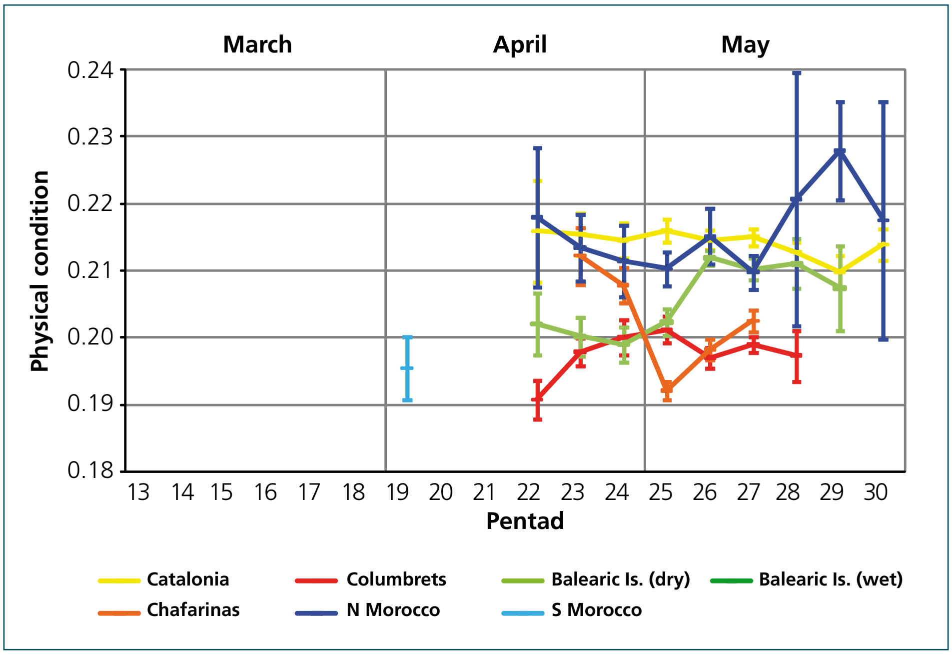


Figure 7. Temporal variation of physical condition according to area.

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

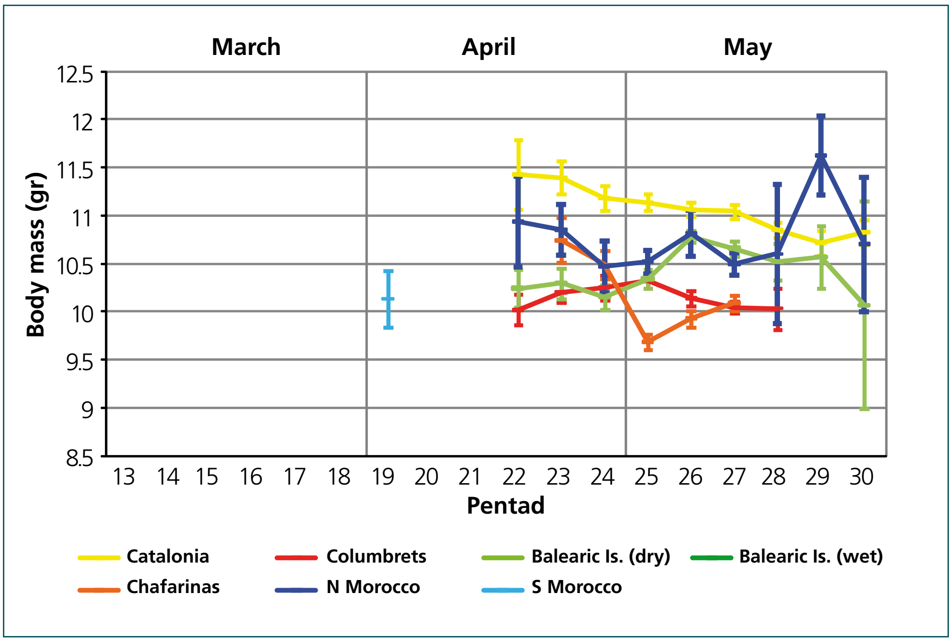
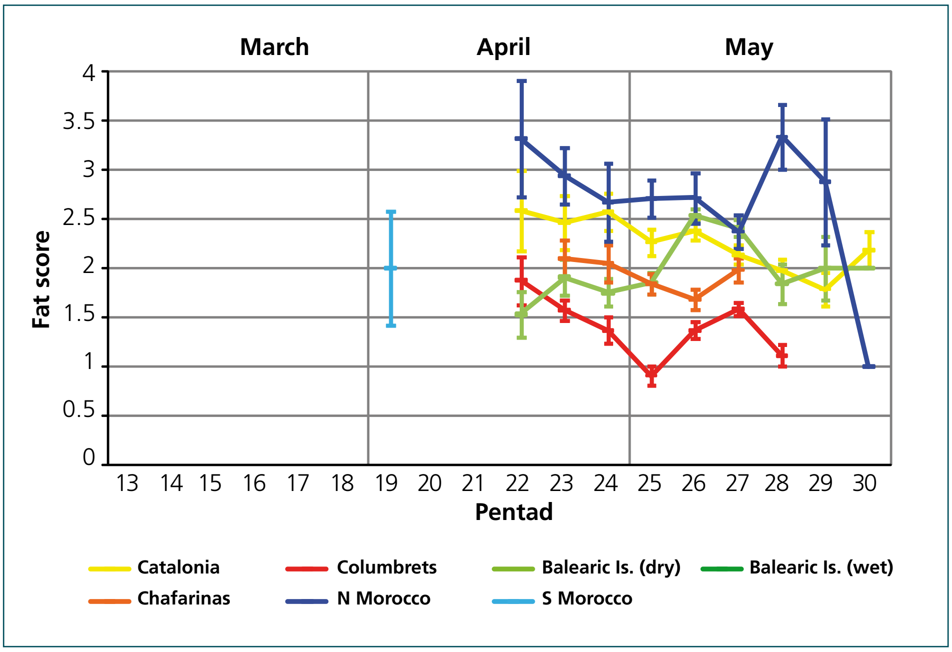


Figure 9. Temporal variation in fat score according to area.



Subalpine and Moltoni's Warblers *Sylvia cantillans* and *Sylvia moltonii*

Carles Barriocanal & David Robson

Range

The taxonomy of the Subalpine Warbler complex has changed markedly in recent years, first due to the addition of another subspecies to the three traditionally accepted taxons (Gargallo, 1994) and, more recently, due to the fact that this complex can now be split into two distinct species: *S. cantillans* includes all three previously accepted subspecies, while *S. moltonii* is now ranked as a full species (Shirihai et al., 2001; Brambilla et al., 2008). Both species breed in the Mediterranean Basin, from sea level up to 2000 m in the High Atlas of Morocco (Hagemeijer & Blair, 1997; Cramp, 1998). The nominate *S. c. cantillans* occupies continental SW Europe and has a somewhat distinct population in the central and southern Italian Peninsula and Sicily, whereas *S. c. inornata* is present in NW Africa and *S. c. albistriata* in SE Europe (Brambilla et al., 2008). Moltoni's Warbler *S. moltonii* (*S. subalpina* according to Bacetti et al., 2007) occupies the W Mediterranean islands (Corsica, Sardinia and Balearics) and N Italy. All populations are migratory and winter in tropical Africa, chiefly along the southern edge of the Sahara, from Mauritania and Senegal to Sudan (Cramp, 1998). At the study sites, only *moltonii* breeds –in low numbers on Cabrera– and at the rest of sites only migrants are present.

Migratory route

Only three recoveries are available and, interestingly, all involve SW movements (fig. 1). Two adult males ringed on L'Illa de l'Aire were recovered 9 and 27 days later on Cabrera (140 km to the SW), one of them confirmed as Moltoni's. The other recovery is of an adult female ringed at Els Aiguamolls and recovered two days later on Els Columbrets (330 km to the SW). Since there is a small breeding population of Moltonii's Warbler on Cabrera, these recoveries may reflect reverse movements towards breeding sites by overshooting migrants. The bird recovered on Els Columbrets may be a similar case, although we have no clues as to its final destination.

Overall, birds are captured in quite good numbers in the Balearics/Els Columbrets, continental Spain and NE Morocco, suggesting that migration takes place across a broad front through the W Mediterranean (fig. 2). In the Balearics, bird numbers tend to increase eastwards. High frequencies and raw number of captures at sites with unsuitable habitat such as the tiny islands of L'Illa de l'Aire and Els Columbrets, as well as at L'Alfacada (near the tip of the Ebro delta), suggest that these sites act as attraction points for many migrants needing to find resting areas whilst crossing the sea. This view is further supported by the reverse movements observed in some of these birds.

Our data indicates that the nominate race of the Subalpine Warbler is almost the only taxon of this group trapped in Catalonia, L'Illa Grossa and mostly so on Els Columbrets. Moltoni's Warbler is occasionally trapped in Catalonia and less rarely so on Els Columbrets. In Morocco both *cantillans* and *inornata* should be frequent, but their exact frequency is unknown; although it is expected to migrate over this country, so far no records of *moltonii* have been reported (Thévenot et al., 2003; Gargallo, pers. obs.). In the Balearics both *cantillans* and *moltonii* are equally common and the eastern race *albistriata* is also trapped with some regularity, albeit in very low numbers. Interestingly, on L'Illa de l'Aire, *moltonii* is particularly common (*c.* 50% of all captures), even though it does not breed on this tiny island or on nearby Menorca. As shown by the recoveries (fig. 1), a good number of these birds may be overshooting migrants breeding in more southern Balearic islands (Mallorca, Cabrera), although others may head onwards to Corsica or Sardinia.

Phenology

Subalpine Warblers (not including *moltonii*) mostly migrate through the study area from mid-March to mid-May, the main passage period taking place from between late March and mid-April (fig. 3). The overall pattern is similar to that reported in S France (Isenmann, 1989a), Malta (Gauci & Sultana, 1976) and the Tyrrhenian islands (Spina et al., 1993). The lack of data from March in N Morocco prevents a comparison between this area and Catalonia. However, published data from Gibraltar (Finlayson, 1992) and N Morocco (Thévenot et al., 2003) indicates that passage takes place somewhat earlier in these areas and birds are already rather common in early March. In S and SW Morocco passage occurs distinctly earlier, from late February to mid-April, and peaks during the second half of March (Thévenot et al., 2003; Gargallo et al., unpubl.). Moltonii's Warbler clearly migrates about three weeks later (fig. a), usually beginning in early April and finishing in late May, although most pass through between mid-April and mid-May. Such delayed passage has been linked to the characteristic later breeding season of this taxon (Gargallo, 2002).

Males pass earlier than females (differences in median dates 9 and 6 days in adults and second-year birds, respectively) and adults somewhat earlier than second-year birds (7 and 4 days earlier in males and females, respectively; fig. 3). No data is available for Moltoni's since females are very hard to tell apart from Subalpines and ageing is complex (*cf.* Shirihai et al., 2001). Similar sex-related differences have also been found in Malta (Gauci & Sultana, 1976), but not in Italy (Rubolini et al., 2004), the latter maybe because of the inclusion of a certain number of Moltoni's Warblers in the dataset.

Biometry and physical condition

Mean wing lengths vary from 57.9 in N Morocco to 59.9 in wet Balearics, within the range reported in various regions of W and C Mediterranean (Cramp,1998; Shirihai et al., 2001), but shorter than in the E Mediterranean, where the eastern, longer-winged race *albistriata* occurs (Morgan & Shirihai, 1997). Birds from N Tunisia also show significantly higher values (mean 62.3, n = 82; Waldenström et al., 2004), which suggests that there is a noticeable passage of *albistriata* and *moltonii* there, the latter also longer-winged than *cantillans*. Mean third primary lengths range between 43.1 in S Morocco to 46.2 in the wet Balearics (table 1), also somewhat less than reported in the Tyrrhenian islands (mean 46.4, n = 4,041; Spina et al., 1993), probably due to similar reasons as in Tunisia. The third primary length tends to decrease over time in Catalonia and on Els Columbrets (fig. 6), as previously found in the C Mediterranean (Spina et al., 1993), reflecting the differential migration of sex and age groups detailed above (males and adults being longer-winged; Cramp, 1998; Shirihai et al., 2001). This pattern is obscured in the Balearics due to the differential passage of *cantillans* and *moltonii* (the tendency to increase in length observed in the Balearics from late April onwards is due to the passage of male Moltoni's Warblers).

Mean fat scores vary between 1.6 on Els Columbrets and 3.7 in N Morocco (3.8 in the small dataset from S Morocco), within the range recorded on the islands of the C Mediterranean (Spina et al., 1993). Physical condition tends to increase slightly during the season, but no overall pattern is observed in fat reserves (figs. 7, 9). Mean body mass varies from 8.7 on Els Columbrets to 10.0 in N Morocco without any clear overall seasonal trend (fig. 8). In Catalonia body mass decreases significantly but in the dry Balearics the opposite is observed, probably due to the inclusion, late in the season, of some breeding birds (Moltoni's) from Cabrera. Birds from Catalonia have significantly higher body mass and fat reserves than those from the Balearics (dry) and Els Columbrets, while those from N Morocco have the highest mean figures for body mass, fat and physical condition out of all these areas. Lower values on islands reflect the energy spent on sea crossings, while values reported from Catalonia suggest that during migration through continental Spain birds are able to regain some mass. Data from the wet Balearics is too scarce to provide any relevant information.

Other than N Morocco, mean values are similar to those reported in S France (9.2, n = 122; Isenmann, 1989a) and the Tyrrhenian islands (9.2, n = 4,011; Spina et al., 1993). Mean body mass in N Morocco is similar to that reported from N Tunisia (9.7, n = 82; Waldenström et al., 2004), but somewhat higher than that reported elsewhere in NW Morocco during March (9.3, n = 10; Cramp, 1992). Data from S Morocco is very scarce, but mean body mass is similar to that reported in a nearby area by Gargallo et al. (unpubl.; mean 9.0, n = 385) and higher than that given by Ash (1969; mean 8.3, n = 17). Body mass in N Morocco is *c.* 11-22% above that recorded in S Morocco, indicating that birds regain considerable energetic reserves while in NW Africa. Birds migrating along the Atlantic coast, however, may be in less of a hurry since data from Souss Massa (SW Morocco) indicates that birds arrive in better condition there (mean 9.7, n = 10; Robson & Durany, unpubl. data), probably reflecting the more favourable environmental conditions found along the west coast of Africa.

As observed in other species, birds stopping on Las Chafarinas have significantly lower fat scores and body mass than at Kerbacha (fig. 4), although these islands are only a few kilometres north of the Mediterranean coast of Morocco, a sign that a high proportion of birds landing on these islands are in poor body condition and need to stop. Given the proximity of the mainland, a good number of these birds are probably migrants forced to reverse their migration direction after failing to cross the Mediterranean Sea.

Stopover

Stopover length is short and averages range from 2 to 6 days depending on the area (fig. 5). The percentage of retrapped birds is in general also quite low, varying widely between 3% on Els Columbretes to 18% in N Morocco (table 2). In general, birds tend to stopover more frequently in Catalonia and, particularly, N Morocco, although available data do not demonstrate if birds are able to refuel at all. The wetlands where the study sites are placed, however, may not be the best refuelling habitats for a species linked to dry Mediterranean scrublands. In more suitable habitats on Malta, for example, spring migrants showed a general increase in weight, with daily mass gains in the range of 0.1-0.9 (Gauci & Sultana, 1976). Data from Las Chafarinas indicates a positive fuel gain, although the sample size is too small to be conclusive.

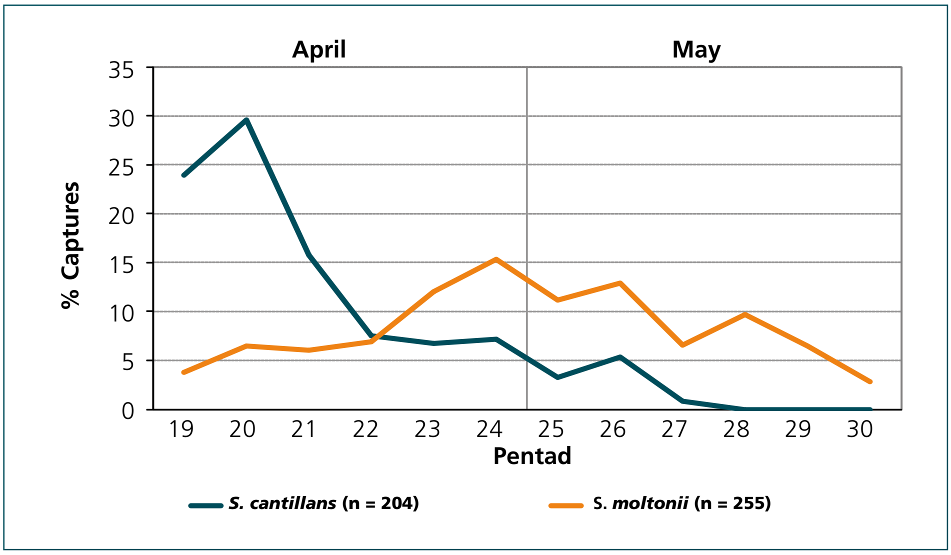


Figure a. Temporal variation in the frequency of captures of *S . cantillans* and *S. moltonii* (data from the Balearic islands only).

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	662	59.0 ± 1.6 (52.5-64.0)	45.5 ± 1.4 (40.5-50.0)	9.3 ± 0.8 (7.3-13.7)	2.8 ± 1.3 (0-6)
Columbrets	566	58.8 ± 2.0 (51.0-65.5)	44.6 ± 1.6 (40.0-50.0)	8.7 ± 0.9 (5.5-11.9)	1.6 ± 1.2 (0-6)
Balearics (dry)	2,036	59.3 ± 2.0 (51.0-65.5)	45.5 ± 1.8 (40.0-52.5)	8.9 ± 1.0 (5.3-15.1)	2.3 ± 1.2 (0-7)
Balearics (wet)	10	59.9 ± 1.1 (58.0-61.5)	46.2 ± 0.9 (45.0-47.5)	9.1 ± 0.3 (8.6-9.6)	2.6 ± 1.2 (1-4)
Chafarinas	22		44.0 ± 1.4 (42.0-46.5)	9.2 ± 0.7 (8.3-11.2)	2.0 ± 1.4 (0-5)
N Morocco	58	57.9 ± 1.6 (54.0-62.5)	44.4 ± 1.3 (42.0-47.5)	10.0 ± 1.0 (7.8-12.2)	3.7 ± 1.6 (0-7)
S Morocco	4	58.6 ± 0.3 (58.5-59.0)	43.1 ± 0.8 (42.5-44.0)	9.1 ± 0.1 (8.9-9.2)	3.8 ± 0.5 (3-4)

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	-0.08 ± 0.11 (46)	0.05 ± 0.16 (18)	-0.05 ± 0.06 (134)		0.18 ± 0.17 (2)	-0.30 ± 0.34 (11)
Retraps >1 day	-0.02 ± 0.10 (30)	0.04 ± 0.14 (8)	0.00 ± 0.06 (94)		0.18 ± 0.17 (2)	0.01 ± 0.20 (6)

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

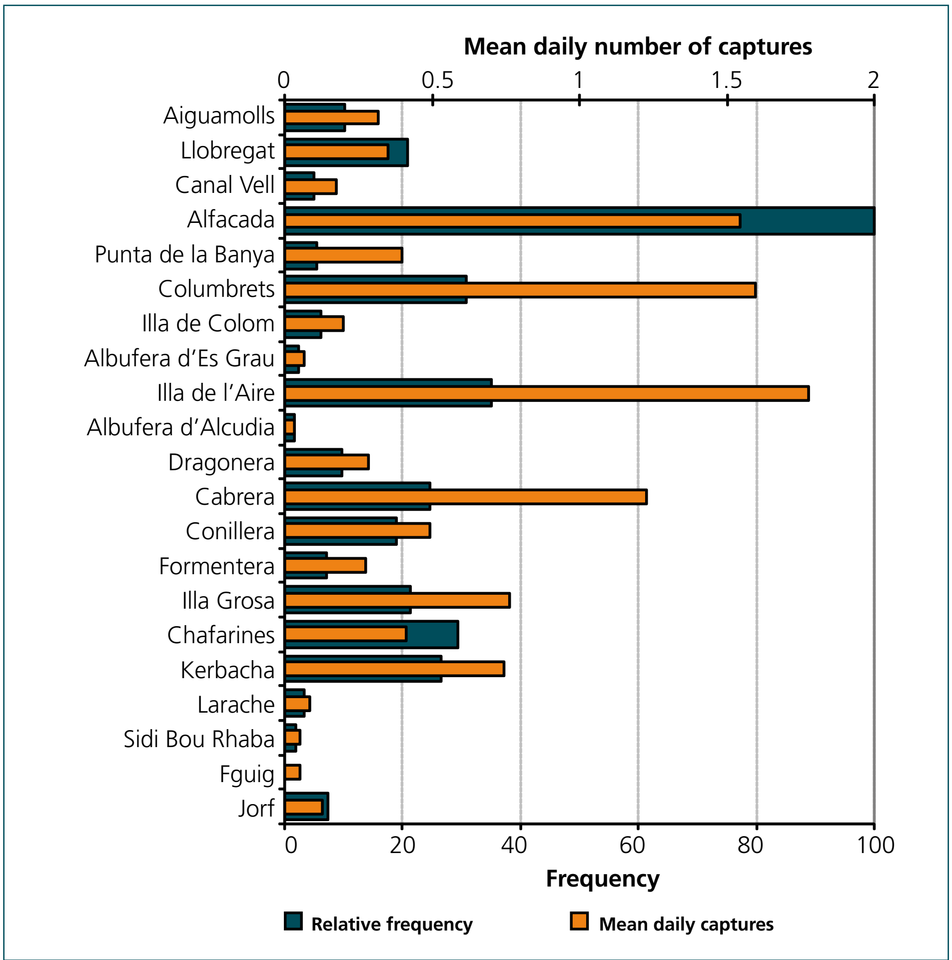


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

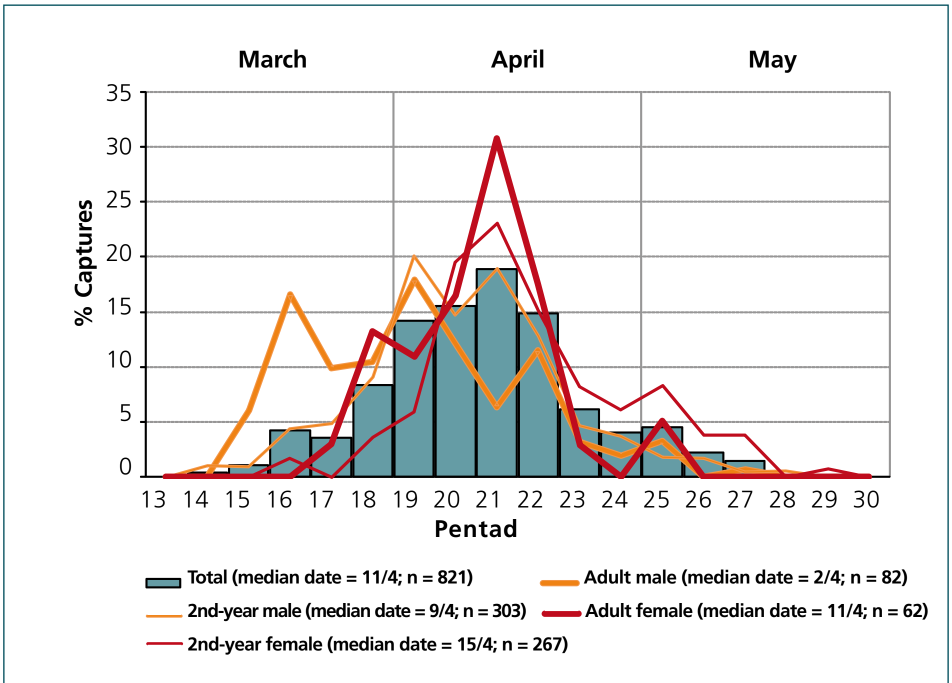


Figure 3. Frequency of captures during the study period (not including *moltonii*).

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

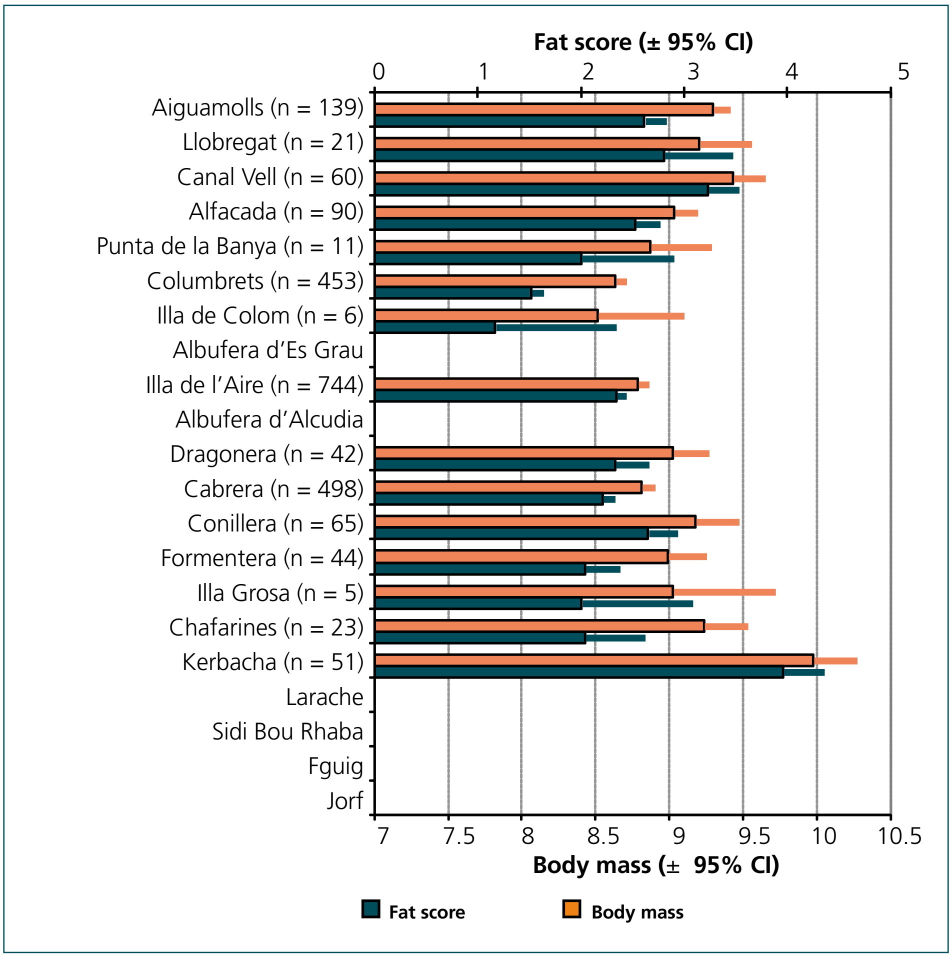
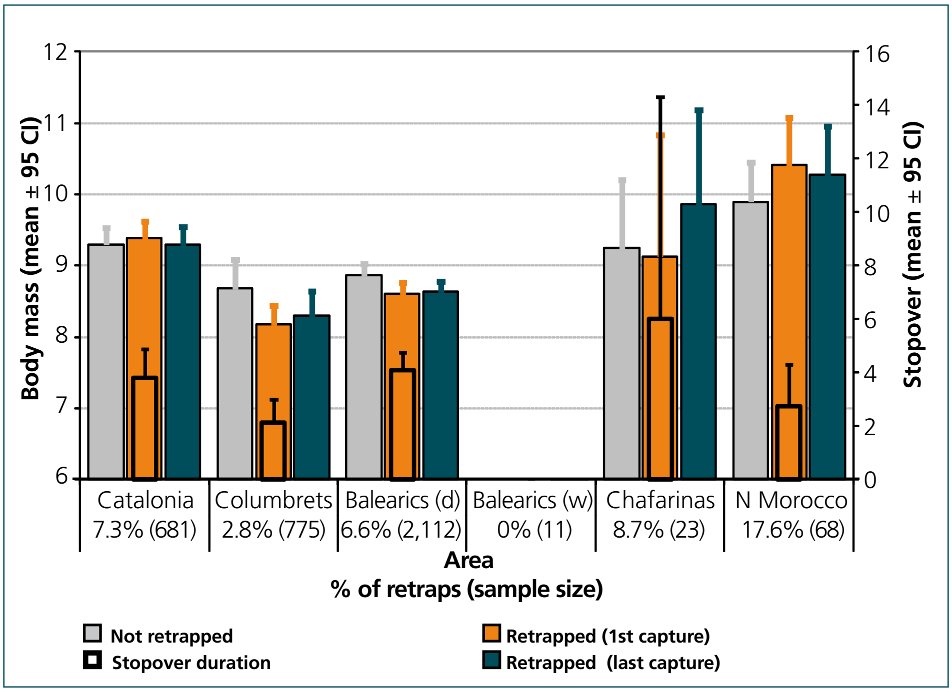


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



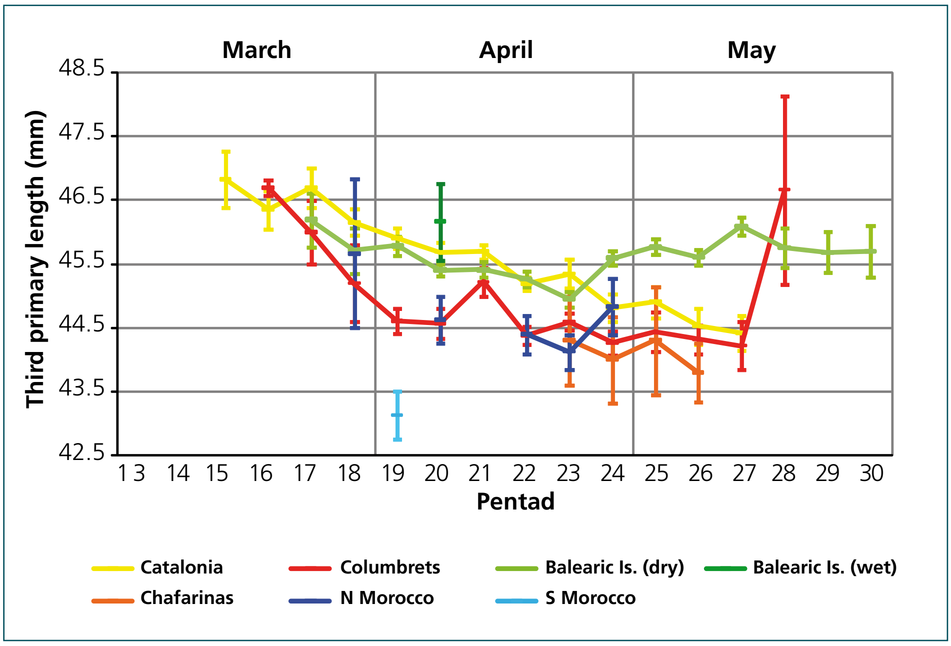


Figure 6. Temporal variation of third primary length according to area.

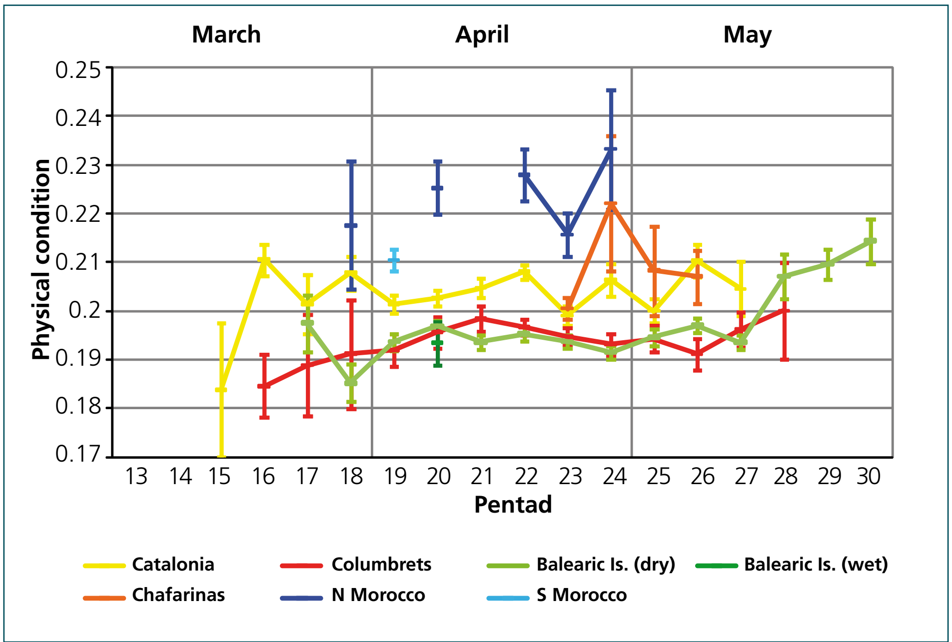


Figure 7. Temporal variation of physical condition according to area.

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

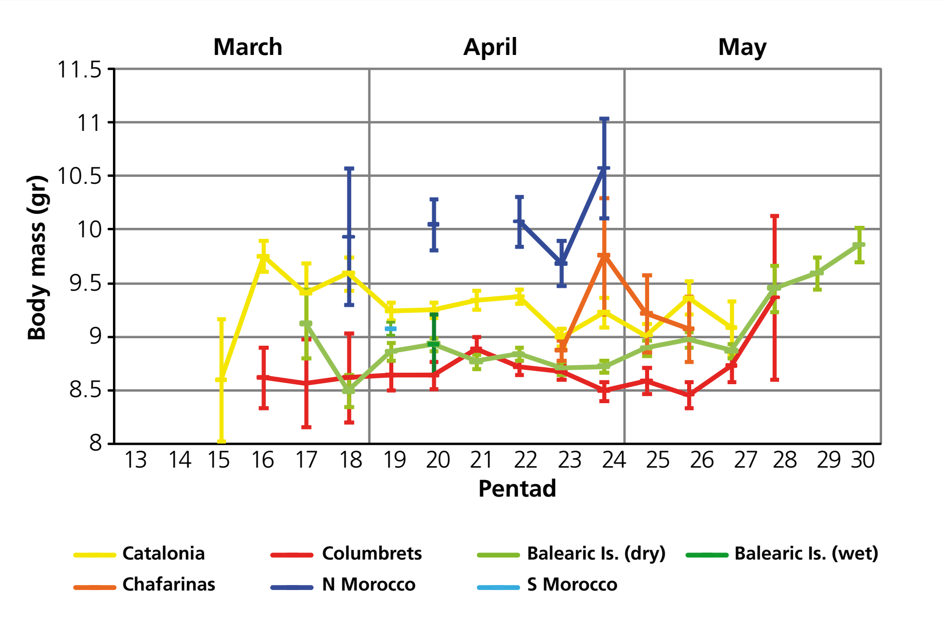
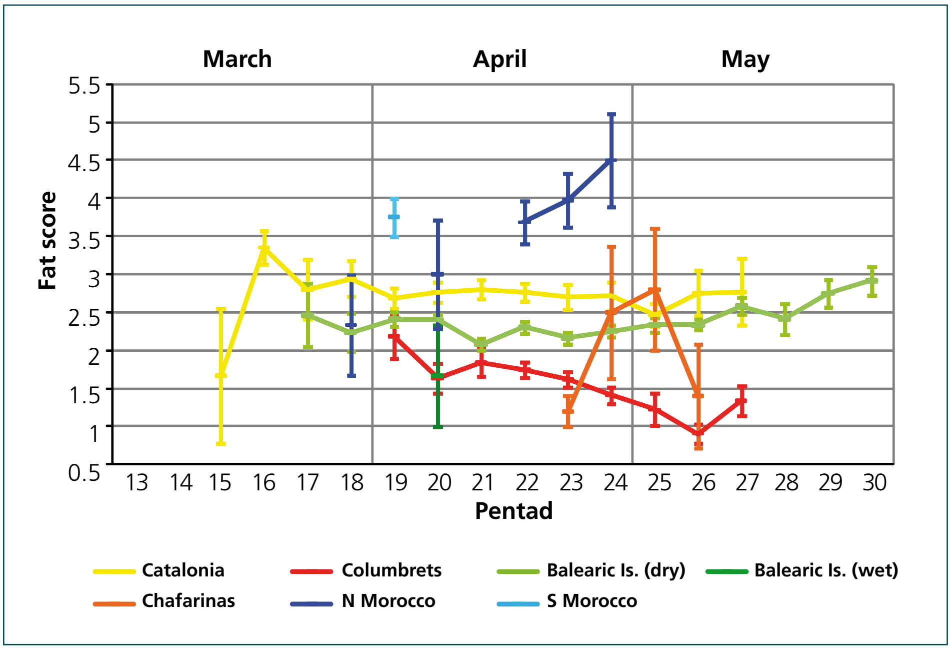


Figure 9. Temporal variation in fat score according to area.



Whitethroat

Sylvia communis

Raül Escandell & Óscar García

Range

The Whitethroat breeds throughout much of Europe, except for the northernmost areas and parts of the Mediterranean Basin, and then eastwards through western C Asia as far as Lake Baikal (Shirihai et al., 2001). All populations are migratory, wintering in sub-Saharan Africa, from Senegal east to Ethiopia and south to S Africa; birds breeding west of 10ºE tend to move SW to winter in West Africa, while those of more eastern origin head more S and SE towards E and S Africa (Zink, 1973; Cramp, 1992). Only the nominate subspecies appears in the W Mediterranean region (Shirihai et al., 2001). This species does not breed at any of the ringing sites.

Migratory route

The Whitethroat has a clear SSW-NNE direction of migration; nevertheless, some birds undertake N or NNW movements, in all cases towards the British Isles (fig. 1). This is the case of a second-year female ringed in the Balearics on 22 April and recovered 27 days later in N Scotland and reflects the more direct route followed during this season by birds originating in the British Islands (Wernham et al., 2002). Available data, thus, indicates that in spring birds cross the area using a more due N main axis of movement than in autumn, when birds migrate largely NE-SW. The scarcity of spring recoveries in the western Iberian Peninsula (Cantos, 1992) further reflects this pattern. It is interesting to note that some birds move towards eastern C Europe, well eastwards of the 10ºE migratory divide roughly observed during autumn migration (Cramp, 1992). Moreover, some birds seem to cross the Mediterranean by different routes in different years, as shown by a bird trapped in the Balearics in May 1992 and recovered on the Tyrrhenian islands in April 1994, 923 km away (but at a similar latitude).

The Whitethroat is happy to cross the Mediterranean across a broad front, as indicated by both the raw number of captures and relative frequencies on stations located on islands (fig. 2). Passage is also considerable in the C Mediterranean and this species is also trapped in good numbers in the Tyrrhenian area, representing the bulk of Italian spring recoveries (Spina & Volponi, 2009; Spina et al., 1993).

Phenology

The first birds pass through the area at the end of March, although the main passage period takes place from mid-April to mid-May (fig. 3). Passage declines during the second half of May, but is still noticeable towards the end of the month, indicating that migration continues into early June. The overall phenological pattern is similar in the three main study areas (Catalonia, N Morocco and the Balearics/Els Columbrets), although on the islands passage takes place on average *c.* 5 days later and is somewhat more patent during the second half of May. In the Strait of Gibraltar and N Morocco passage can occasionally begin in late February, but usually not before late March (Finlayson, 1992; Thevenot et al., 2003). In S Morocco passage usually gets underway in mid-March and peaks in April (Gargallo et al., unpubl.). Median dates of passage through the Tyrrhenian islands are on average 2-9 days later than in our study area (Pattersson et al., 1990; Rubolini et al., 2005), as shown by the earlier arrival of birds in W as opposed to C Europe (Cramp, 1992).

Males pass through the W Mediterranean somewhat earlier than females (medians 4-6 days earlier depending on age group) and adults slightly earlier than second-year birds (2-4 days; fig. 3). Similar sexual differences have been observed on the Tyrrhenian islands (median passage of males also 4 days earlier; Spina et al., 1994; Rubolini et al., 2004) and the Strait of Gibraltar (Finlayson, 1992).

Biometry and physical condition

Mean third primary lengths range from 53.2 on Las Chafarinas to 56.8 in S Morocco (table 1). Mean values for wing lengths vary from 71.1 in N Morocco to 73.3 in the wet Balearics. These figures are slightly smaller than those reported from C Mediterranean (mean 55.8 for third primary, n = 19,834, and 74.0 for wing length, n = 12,849; Messineo et al., 2001), probably due to the slight clinal variation in size shown by this species towards the east (Cramp, 1992). This pattern suggests that migration occurs across a broad front across the Sahara. There is a slight but significant decreasing trend in the mean third primary length during the season, especially marked in the dry Balearics, Els Columbrets and Catalonia, a reflection of the differential migration of the sexes (longer-winged males pass earlier; see above).

Mean values for fat score vary between 1.1 on Las Chafarinas and 3.5 in N Morocco (4.3 in the small dataset from S Morocco), while mean body mass varies from 12.9 on Las Chafarinas to 15.1 in the wet Balearics (table 1). In the dry Balearics, body mass, fat and physical condition increase significantly during the season but the opposite pattern is observed on Els Columbrets (figs. 7-9). Body mass on islands of the C Mediterranean (14.0, n = 20,178; Messineo et al., 2001) is similar to that from the dry Balearics and Els Columbrets. In Gibraltar on the north side of the strait average body mass (14.0, n = 26; Finlayson, 1981) is only slightly lower than in N Morocco and Catalonia, and averages reported further north in S England (mean 14.3, n = 200) and Germany (Helgoland; mean 15.0, n = 16) are also similar. Body mass in N Tunisia (mean 16.0, n = 51; Waldenström et al., 2004) is higher than in N Morocco, while that given here for S Morocco is also below that of much larger datasets from the nearby sites of Defilia (mean 13.7, n = 58; Ash, 1969) and Merzouga (mean 14.0, n = 63; Gargallo et al., unpubl.). Overall, these results indicate that birds gain some mass during their stay in NW Africa, but only to a limited extent: birds from N Morocco are in better body condition (fat, physical condition), although their average body mass is only *c.* 4-11% higher than in S Morocco. Mean body mass, however, does not seem to vary greatly from N Morocco to C Europe, suggesting that migration takes places in short bouts that do not require long stopovers or marked gains in mass (as shown below).

Birds from the wet Balearics have significantly greater body mass and fat reserves than those from more isolated and sparsely vegetated islands (*e.g.* the dry Balearics and Els Columbrets), suggesting that those stopping on these latter areas include a higher proportion of birds urged to stop. On the other hand, Las Chafarinas have the lowest averages for body mass and fat score (significantly lower than all the study areas except Els Columbrets) (table 1; figs. 8-9). Differences are particularly large in relation to continental N Morocco (mean body mass and fat being even below that usually recorded in S Morocco) and, above all, Kerbacha (fig. 4), located only a few km to the south of Las Chafarinas. Data from Las Chafarinas and Kerbacha comes from different years and mean values on Las Chafarinas were lower in all available years, but only significantly so in 2000. The average third primary length in Las Chafarinas is also significantly the lowest, except when compared to continental N Morocco (differences are nearly significant when compared to Kerbacha). As observed in other species, these results suggest that Chafarinas attract birds in poor body condition, apparently birds often forced to change or reverse flight direction due to unfavourable meteorological circumstances encountered during the sea crossing (note that Las Chafarinas are less than 4 km off the Moroccan coast). The fact that birds trapped on Las Chafarinas also tend to have shorter wings suggests that these birds may be more prone to suffer from such unfavourable circumstances (particularly strong head winds) or that females and younger individuals (with shorter wings) may take fewer risks when migrating (having less need to migrate faster and arrive earlier), and thus be more inclined to stop at suboptimal habitats or reverse migration when facing problems.

Stopover

The highest percentage of recaptured birds occurs in N Morocco, Catalonia and the dry Balearics, although overall figures are low (fig. 5). Mean stopover length is rather short in all areas too, ranging from *c.* 2-4 days. Birds do not tend to gain or lose body mass during their stopover in any important or significant way in any of the studied areas (marginally gaining some mass in the dry Balearics) (table 2). At this site, however, those stopping for more than one day have significantly lower body mass than birds not retrapped again (a tendency also observed on Els Columbrets, although the differences are not significant), suggesting that these areas do not offer good opportunities for refuelling and that mostly birds unable to continue their migrations stop in these areas for more than one day. On Las Chafarinas, birds show nearly significant positive fuel deposition rates, although the sample 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	1,142	72.1 ± 2.1 (64.0-80.0)	55.1 ± 1.8 (48.5-60.0)	14.4 ± 1.5 (10.9-22.6)	3.0 ± 1.3 (0-7)
Columbrets	1,219	71.7 ± 2.3 (64.5-79.5)	54.4 ± 2.0 (48.0-61.0)	13.6 ± 1.8 (8.7-21.9)	1.8 ± 1.4 (0-8)
Balearics (dry)	5,443	71.8 ± 2.3 (64.0-80.0)	54.7 ± 2.0 (48.0-61.0)	13.9 ± 1.7 (8.5-21.8)	2.5 ± 1.5 (0-8)
Balearics (wet)	26	73.3 ± 3.1 (69.0-80.0)	55.3 ± 2.2 (52.0-60.0)	15.1 ± 2.9 (10.9-22.7)	3.3 ± 1.7 (1-6)
Chafarinas	41		53.2 ± 1.4 (49.5-56.5)	12.9 ± 1.5 (10.4-18.7)	1.1 ± 1.1 (0-5)
N Morocco	52	71.1 ± 2.5 (66.0-79.5)	54.3 ± 1.5 (49.5-57.0)	14.6 ± 1.6 (11.3-19.2)	3.5 ± 1.7 (0-7)
S Morocco	3	71.8 ± 0.8 (71.0-72.5)	56.8 ± 2.0 (54.5-58.0)	13.1 ± 2.5 (11.6-16.0)	4.3 ± 1.5 (3-6)

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	-0.07 ± 0.14 (61)	-0.22 ± 0.22 (26)	-0.04 ± 0.06 (380)		0.35 ± 0.35 (2)	0.09 ± 0.82 (4)
Retraps >1 day	0.04 ± 0.14 (30)	-0.02 ± 0.28 (10)	0.05 ± 0.05 (249)			

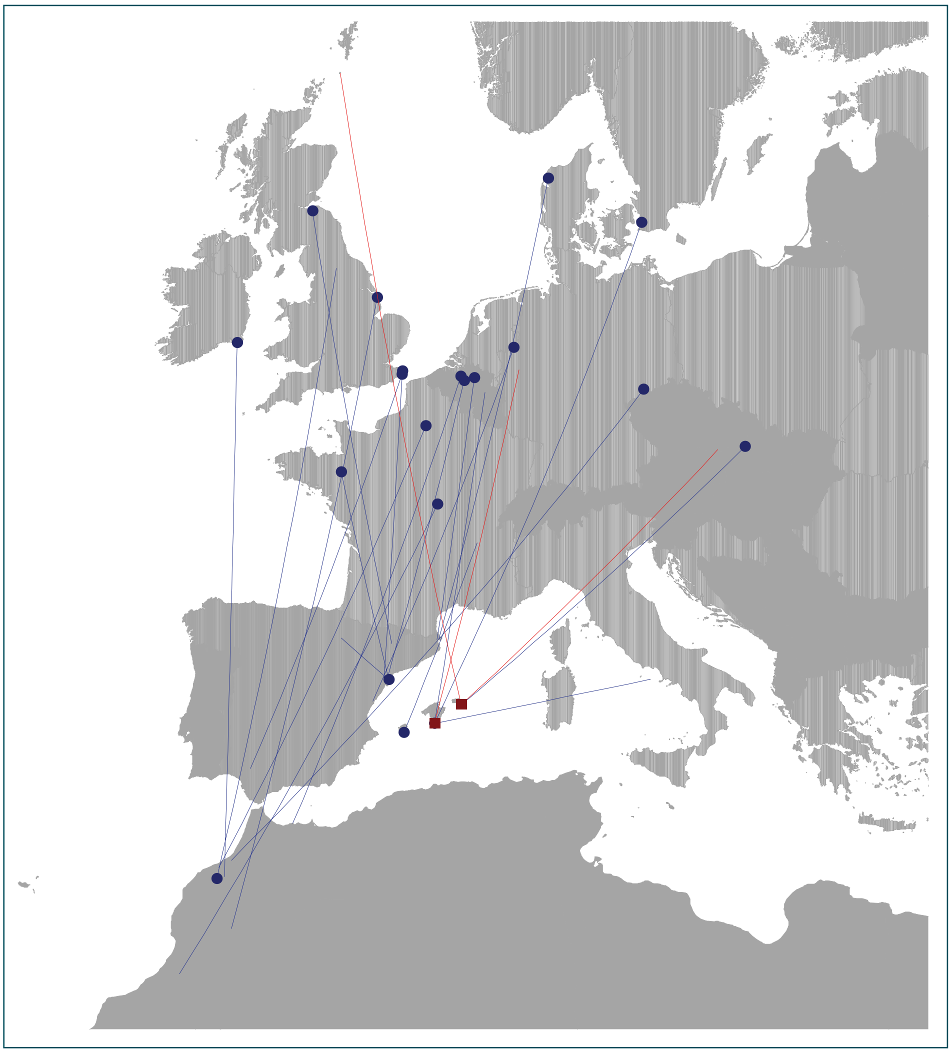


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

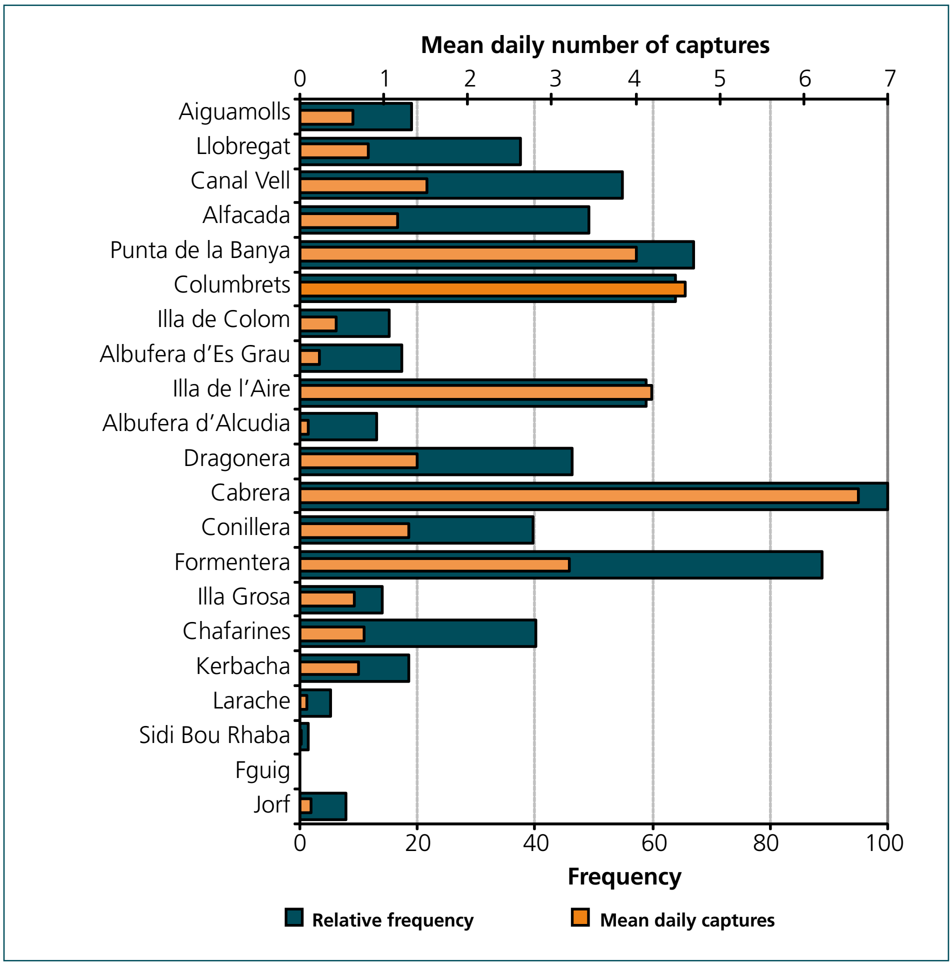


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

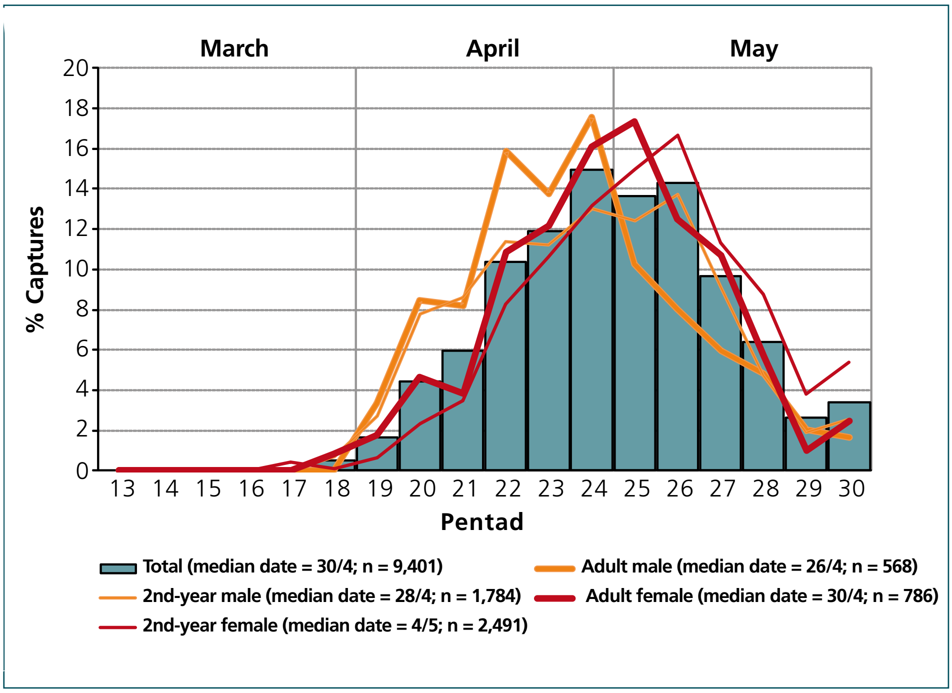


Figure 3. Frequency of captures during the study period.

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

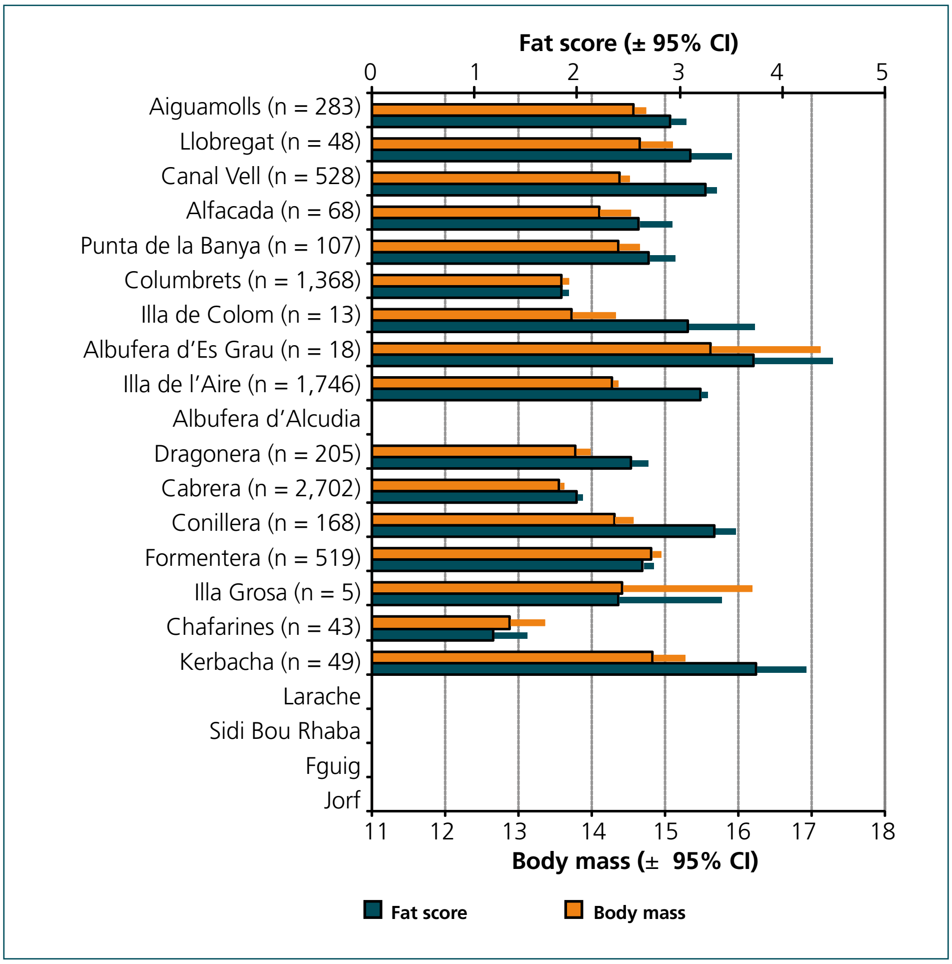
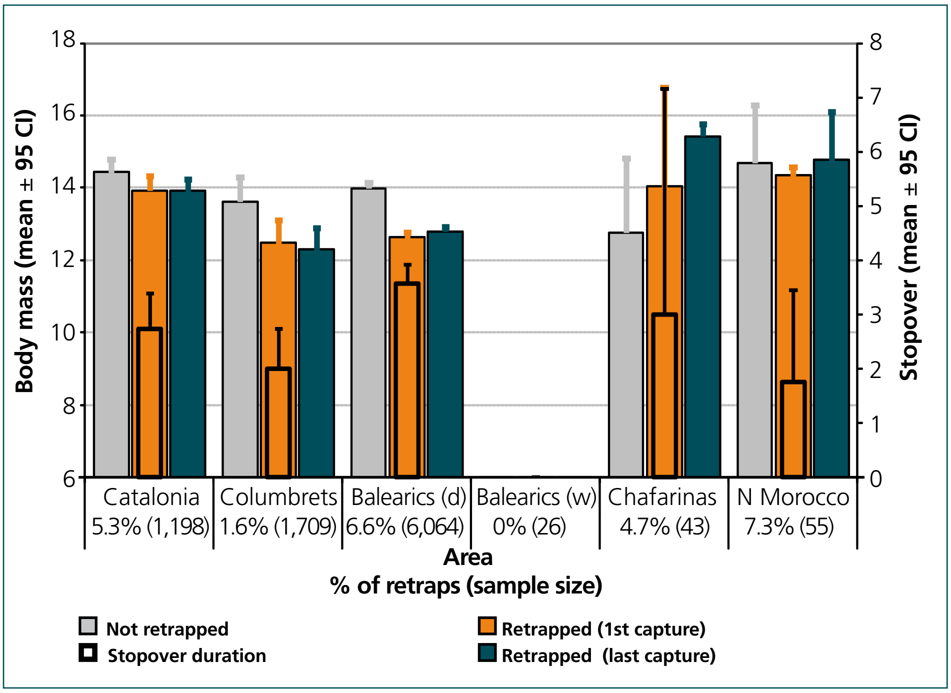


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



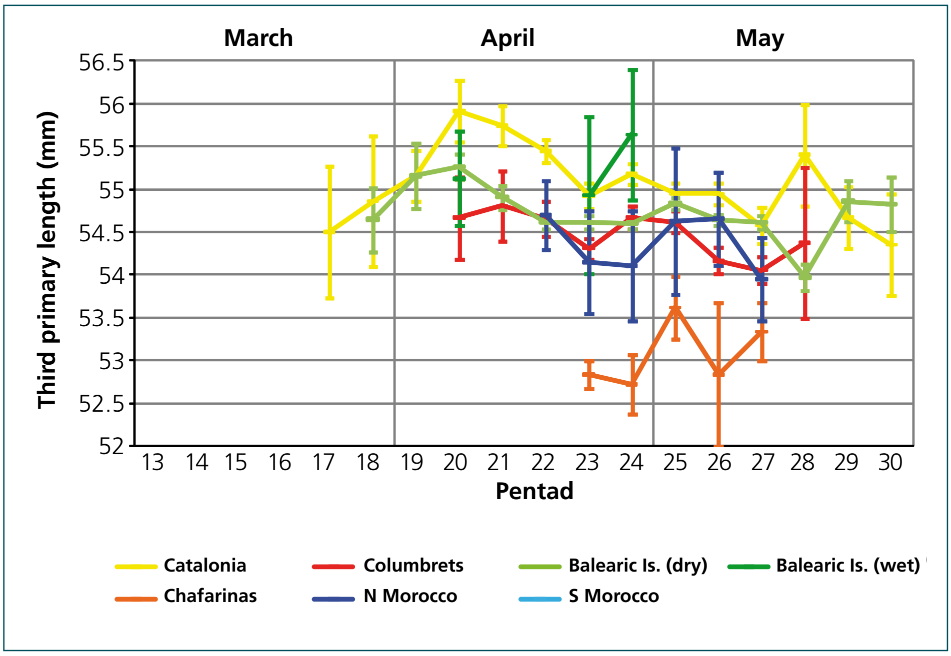


Figure 6. Temporal variation of third primary length according to area.

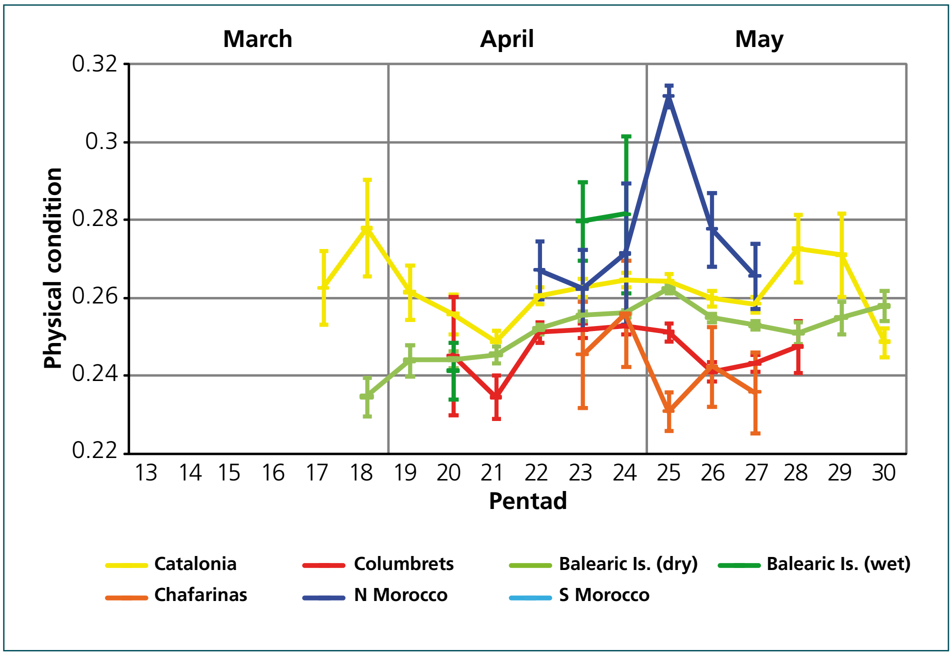


Figure 7. Temporal variation of physical condition according to area.

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

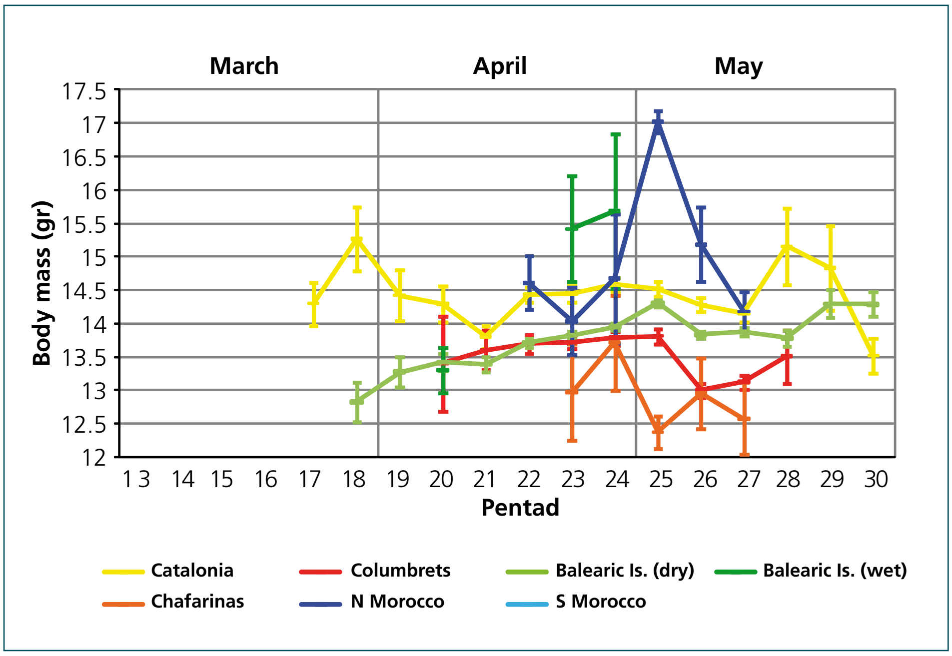
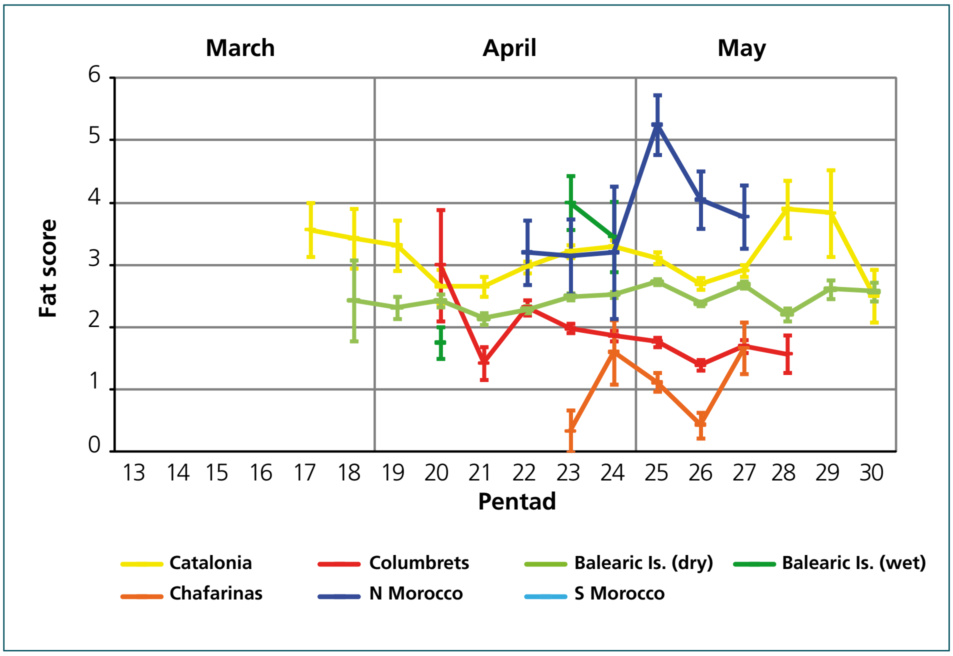


Figure 9. Temporal variation in fat score according to area.



Garden Warbler
Sylvia borin

Hamid Rguibi-Idrissi

Range

The Garden Warbler is a common trans-Saharan migrant that has been a focal species for many studies (Schaub & Jenni, 2000; Shirihai et al., 2001; Ottosson et al., 2005). Its breeding distribution extends throughout most of Europe between 37°-70°N and eastwards between 52°-64°N to western Siberia. All populations are migratory, wintering extensively in Africa south of *c.* 10°N in the west and 3°N in the east, and southwards to S Africa (Urban et al., 1997). The western nominate subspecies *borin* winters from W to E Africa and south to South Africa, occurring progressively more rarely east and southwards; eastern *woodwardi* largely predominates in E and S Africa (Urban et al., 1997). In the study area it breeds in Catalonia but not at the study sites.

Migratory route

The distribution of recoveries shows a main SW-NE direction in this species' migratory movements (fig. 1) along a fairly similar axis of movement in spring and autumn (Zink, 1973; Cramp, 1992). One bird ringed on L'Illa de l'Aire (Menorca) and recovered at Palmaria (Italy), 656 km NE, only two days later characterises perfectly this pattern of movements and suggests that some birds may cover distances across the sea of up to 656 km in a single flight (assuming no stops in between). In spring, however, birds seem to cross continental Spain following a rather narrow central path, avoiding the westernmost and north-westernmost part of the Iberian Peninsula and to a lesser extent coastal Mediterranean areas (Cantos, 1992). The few recoveries from Catalonia (n = 2), as well as the relative low raw numbers of birds trapped in this area, further supports this idea. Interestingly, recoveries are much more frequent in the Balearics/Els Columbrets (n = 18) where, moreover, birds show a significantly more due N axis of movement (mean direction 13.89°NE, instead of 36.50° from Catalonia [two individuals only] and 34.44° in the rest of continental Spain). This pattern may reflect the fact that those birds that do cross the W Mediterranean Sea tend to involve birds returning to breeding grounds along a more direct due N route, possibly including a higher proportion of delayed birds in a hurry (*cf.* Barriocanal & Robson, 2006). In fact, birds passing through the Balearics tend to pass somewhat later than those migrating through continental NE Spain (see below). In any case, the scarcity of direct recoveries and the small sample size from Catalonia (at similar longitude to the islands) prevents a more definitive analysis.

A gradual cline from west to central Mediterranean towards longer-winged birds parallels size-related differences in the breeding origin of birds and suggests that birds cross the Mediterranean and the Sahara across a quite broad front (Grattarola et al., 1999, present data;

see below). However, recoveries and the relative frequency of captures (figs. 1, 2; Grattarola et al., 1999) indicate that passage may be more intensive in areas such as central continental Spain (see above) or the C Mediterranean. In the latter area, birds could use the Italian Peninsula and adjacent islands as a bridge for reaching Europe over a more direct NNE route (*cf.* Spina & Volponi, 2009).

This warbler seems to be fairly common in Morocco in spring (Thevenot et al., 2003), when recoveries are more frequent then than in autumn (Moroccan Bird Ringing Centre, unpubl. data). Moreover, some sites in the north of the country have some of the highest relative frequencies of capture recorded in this study (fig. 2). The abundance of captures on isolated islands such as Els Columbrets and on the quasi-island of La Punta de la Banya (in the Ebro delta) suggests that these sites act as attraction points for many migrants urged to find resting areas whilst crossing the sea (a fact further supported by the poor body condition of birds trapped at these sites; see below). Independently of this attraction factor, overall figures for both frequency and the raw number of captures are quite high in the whole of the Balearics/Els Columbrets, supporting the view that large numbers of birds pass through this area.

Phenology

Passage in the W Mediterranean begins in early April and peaks by mid-May (fig. 3). The intensity of migration decreases markedly towards the end of May, but passage extends into the first half of June, outside the study period (Cramp, 1992; Telleria et al., 1999; Thevenot et al., 2003). In the Balearics/Els Columbrets the peak passage takes place 5-10 days later than in Catalonia and Morocco and on average birds pass through these islands 4 days later. The overall phenological pattern is similar to that reported in Morocco, Gibraltar and S France (Blondel & Isenmann, 1981; Thevenot et al., 2003; Finlayson, 1992). Quantitative phenological data from the C Mediterranean indicates that migration occurs there slightly later than in Morocco and continental Spain (Pettersson et al., 1990; Rubolini et al., 2005), although the differences between the C Mediterranean and the Balearics/Els Columbrets are very slight.

Biometry and physical condition

Mean third primary lengths range between 58.8 mm in Las Chafarinas and 61.2 mm in the wet Balearics, while mean wing length varies between 78.0 in N Morocco and 80.3 in the wet Balearics (table 1). Overall, third primary length increases slightly but significantly during the season (fig. 6). This might be related to the late passage of more northern, longer-winged birds, since this species does not have any pronounced sexual size dimorphism and both sexes tend to arrive on breeding grounds at the same time (Cramp, 1992). There is an increase in wing length with longitude, with the largest birds crossing through the most eastern part of the study area. This pattern matches the cline in wing length reported from both the breeding and wintering ranges and during migration across the W and C Mediterranean (Cramp, 1992; Grattarola et al., 1999).

Mean body mass varies from 15.7 on Els Columbretes to 18.0 in the wet Balearics, while mean fat scores range from 1.6 (Els Columbrets) to 3.6 (N Morocco). Body mass, fat and physical condition show an overall increasing trend during the season (figs. 7-9). Though the pattern is unclear in Morocco and on Els Columbrets, in the large datasets of Catalonia and the Balearics, the increase is marked and significant. An improvement in the overall condition of birds is also observed in the C Mediterranean (Spina et al., 1993) and seems to reflect progressively better conditions for feeding either en route or at fattening sites south of the Sahara, or the fact that birds leaving the wintering grounds later have more time to gain weight. In support of this, it is worth mentioning that a distinct, progressive seasonal increase in body mass is clearly observed in spring in Nigerian (Ottosson et al., 2005).

Average body mass and fat scores on the islands of the C Mediterranean (means 15.9 [n = 29,944] and 1.7 [n = 29,023], respectively; Messineo et al., 2001), are similar to those reported on Els Columbrets but lower than in the dry Balearics, reflecting the longer stretch of sea and desert crossed by birds passing through the former group of islands (see also Grattarola et al., 1999). Mean body mass in Catalonia is somewhat higher than at Gibraltar (mean 16.5, n = 48; Finlayson, 1981), but distinctly lower than in N Germany (mean 18.4, n = 27) and N Italy (18.7, n = 10) and slightly lower than in S France (17.2, n = 1,152; Bairlein, 1991). Birds trapped in N Morocco have significantly higher average body mass, fat and physical condition than in all other areas further north except the wet Balearics. Birds are distinctly heavier in Sidi-Bou Rhaba than in Kerbacha (fig. 4), differences being significant in all available years and probably reflecting the higher availability of stopover sites along the Atlantic coast when compared with the east of Morocco, where the desert or semi-desert belt extends further north (Rguibi-Idrissi, 2002). Mean body mass is *c.* 7-12% lower on Els Columbrets and in the dry Balearics, as well as in the south of the Iberian Peninsula (*cf.* Bairlein, 1991), but only 3% lower in Catalonia. Interestingly, in the wet Balearics birds have similar mean masses to that of birds from N Morocco, but significantly higher values than in the dry Balearics (9% more) and even Catalonia (4%). Data on body mass from S Morocco is scarce, but average figures are rather similar to those obtained at nearby sites by Ash (1969; 16.3, n = 17) and Gargallo et al. (unpubl.; 17.2, n = 141).

Our results show that the mean body mass in S Morocco is *c.* 4-8% lower than in the north, indicating that a certain amount of refuelling takes place after crossing the Sahara (see below). This has already been noted by Smith (1979) and in the exhaustive work of Bairlein (1991), and seems also to occur in Tunisia, since the reported average in the north of the country is also quite high (mean 18.5, n = 76; Waldenström et al., 2004). Birds are able to put on weight after reaching continental Spain and the Mediterranean islands as long as they find suitable stopover sites (see also below). As pointed out by Bairlein (1991), this mass gain is only moderate, probably due to possibilities for finding further food en route northwards. In fact, average mass increases from S Iberia to C Europe (present data; Bairlein, 1991).

Birds trapped in the wet Balearics are significantly heavier, are in better physical condition, and have larger fat reserves and longer wings than those from more isolated and sparsely vegetated sites (the dry Balearics). These findings suggest that these latter areas attract a higher proportion of birds in poor body condition that have greater need to land. The fact that these birds also have on average shorter wings suggests that smaller size make them more prone to suffer from unfavourable meteorological circumstances (particularly strong head winds; *cf.* Newton, 2008; Saino et al., 2010), and thus are more inclined to stop at any available site, even including suboptimal or unsuitable habitats (as shown in this case by negative fuel deposition rates; see below). Birds stopping at wetlands on larger islands may also gain mass faster and involve a larger proportion of birds that have already been on land for a few days (either at the site itself or in surrounding areas), which may also contribute to the overall better average body condition at such sites.

Stopover

Birds do not tend to stay at the study sites and those that do stop stay on average only 1-2.5 days (table 2, fig. 5). Variation between areas in terms of the percentage of retraps and stopover length is small, only Els Columbrets having a distinctly lower percentage of retraps. In Catalonia, on Els Columbrets and in the dry Balearics birds that are not retrapped have significantly higher average initial body mass than those remaining for a few days. In retrapped birds, differences between body mass at initial and last capture do not differ statistically in any of the areas. However, fuel deposition rates are significantly positive in Catalonia and N Morocco, when considering retraps of more than one day. On the contrary, in the dry Balearics and on Els Columbrets birds show significant negative fuel deposition rates (when considering the full dataset of retraps). The dataset from Las Chafarinas and the wet Balearics is too small to be able to reach any definitive conclusions.

Our results indicates that in Catalonia, Els Columbrets and the dry Balearics birds in poorer body condition are more prone to stopover for some days, although only those that land in continental wetlands are able to subsequently gain mass. In N Morocco birds can also regain some mass during the stopover, although, unlike in Catalonia, birds are not necessarily forced or more inclined to stay due to poor body condition.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	1,477	79.3 ± 2.2 (69.0-89.5)	60.5 ± 2.0 (51.0-66.5)	17.2 ± 2.0 (11.8-28.8)	2.6 ± 1.3 (0-7)
Columbrets	1,038	78.9 ± 2.6 (70.0-88.5)	60.0 ± 2.0 (50.5-66.5)	15.7 ± 2.0 (9.1-29.5)	1.6 ± 1.2 (0-7)
Balearics (dry)	5,055	79.0 ± 2.4 (67.0-89.5)	60.2 ± 2.1 (50.0-67.0)	16.5 ± 2.2 (9.0-28.8)	2.1 ± 1.4 (0-7)
Balearics (wet)	54	80.3 ± 2.3 (75.0-87.5)	61.2 ± 2.0 (56.0-66.0)	18.0 ± 2.6 (13.3-24.4)	2.9 ± 1.3 (0-6)
Chafarinas	47		58.8 ± 2.1 (52.0-63.5)	16.5 ± 1.7 (13.3-20.1)	2.8 ± 1.5 (0-6)
N Morocco	492	78.0 ± 2.3 (67.0-83.0)	59.6 ± 1.9 (49.0-64.0)	17.8 ± 2.2 (10.5-28.1)	3.6 ± 1.4 (0-7)
S Morocco	9	79.3 ± 1.7 (77.0-83.0)	59.9 ± 1.5 (58.0-63.0)	16.7 ± 2.4 (14.3-21.5)	3.2 ± 1.4 (2-6)

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	0.12 ± 0.17 (61)	-0.53 ± 0.19 (23)	-0.39 ± 0.16 (175)	0.43 ± 0.83 (2)	-0.20 ± 0.87 (4)	0.22 ± 0.43 (26)
Retraps >1 day	0.30 ± 0.15 (33)	-0.1 9 ± 0.21 (7)	-0.11 ± 0.15 (81)			0.44 ± 0.32 (12)

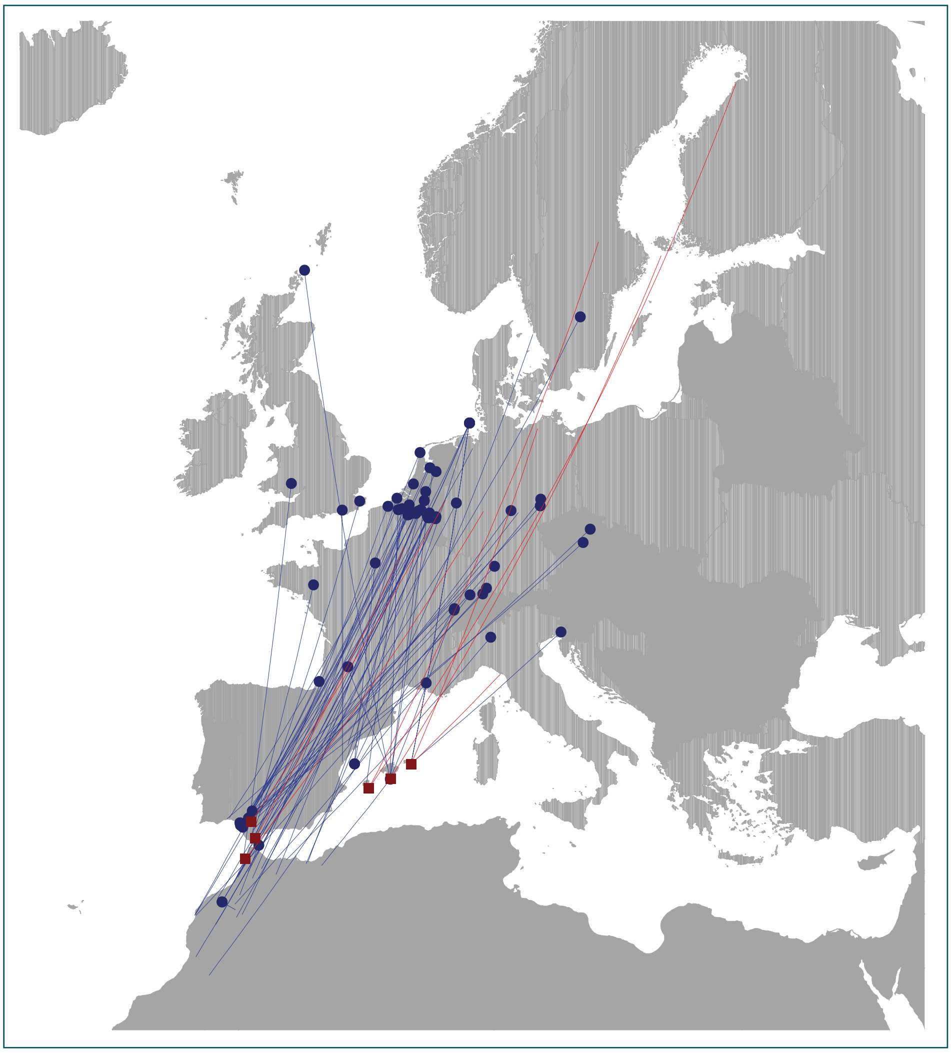


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

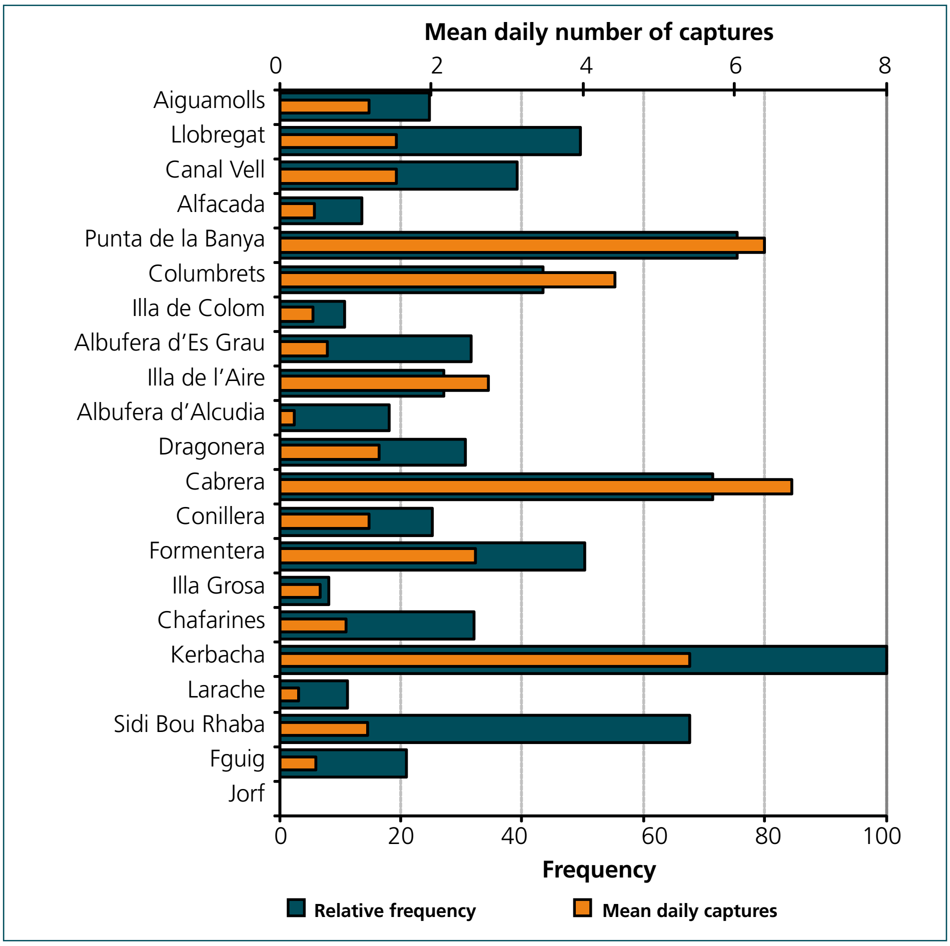


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

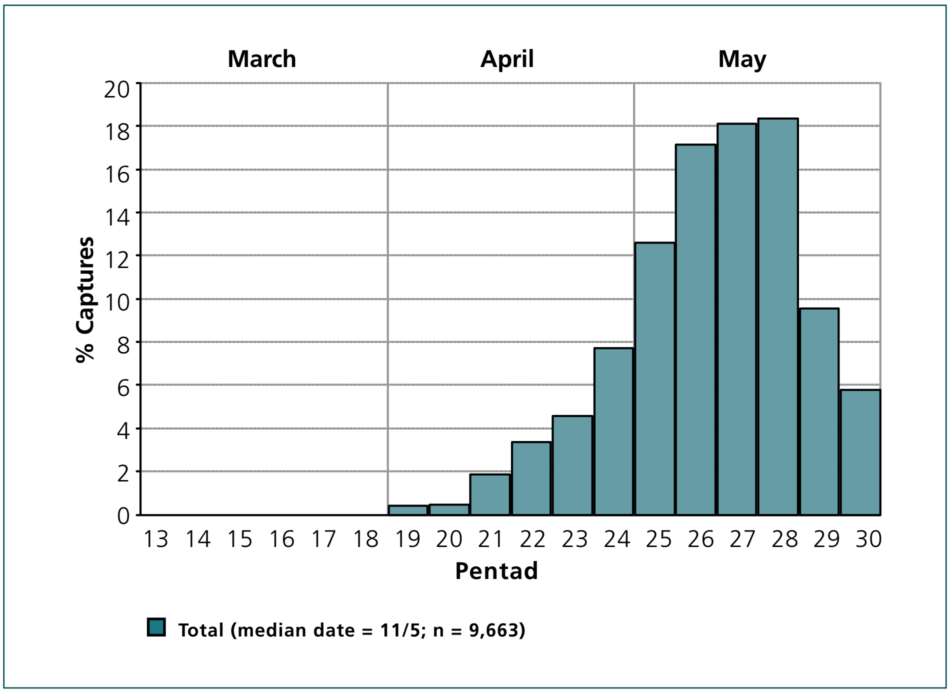


Figure 3. Frequency of captures during the study period.

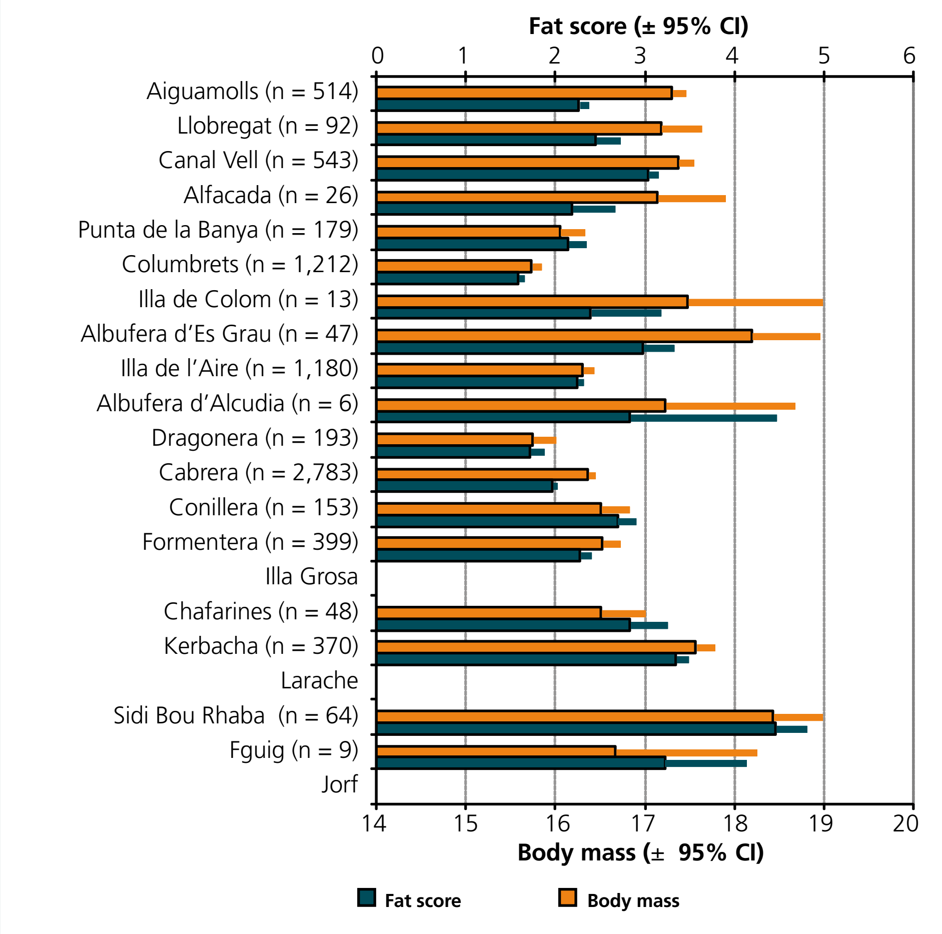


Figure 4. Variation in body mass and fat score according to site during the standard period (16 April to 15 May).

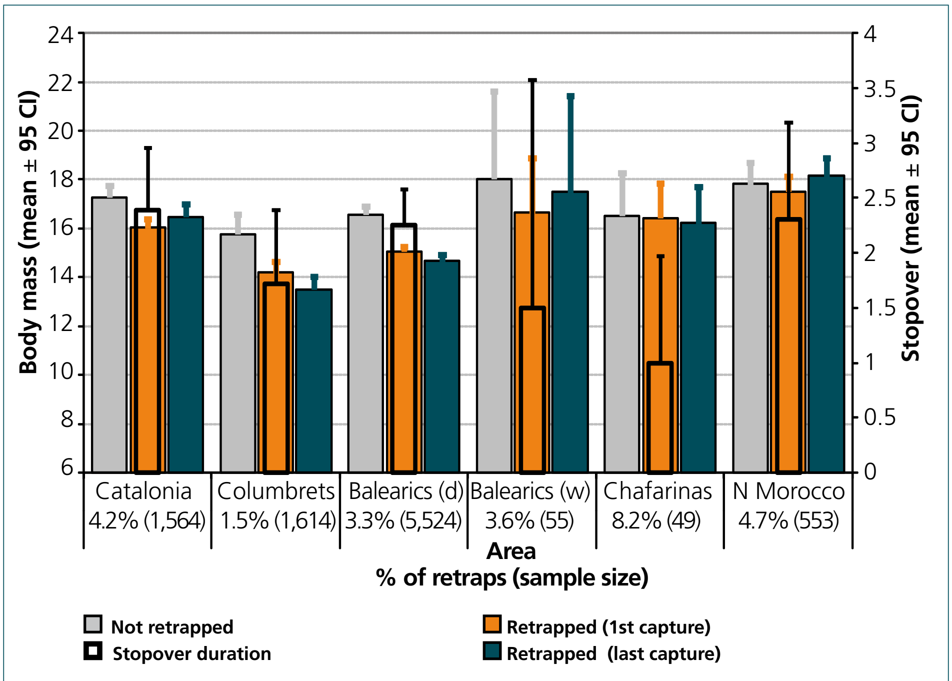


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.

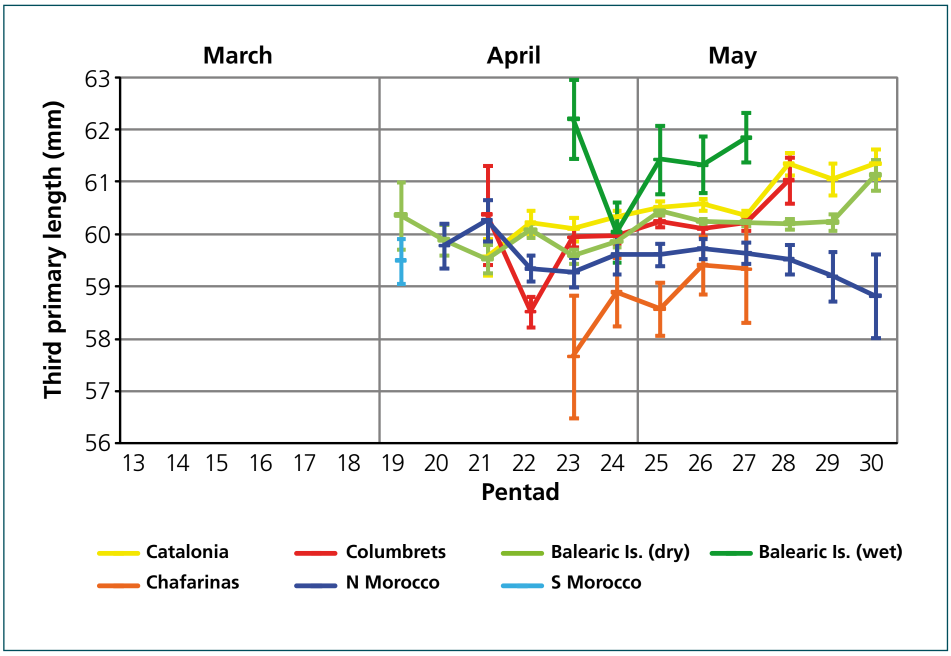


Figure 6. Temporal variation of third primary length according to area.

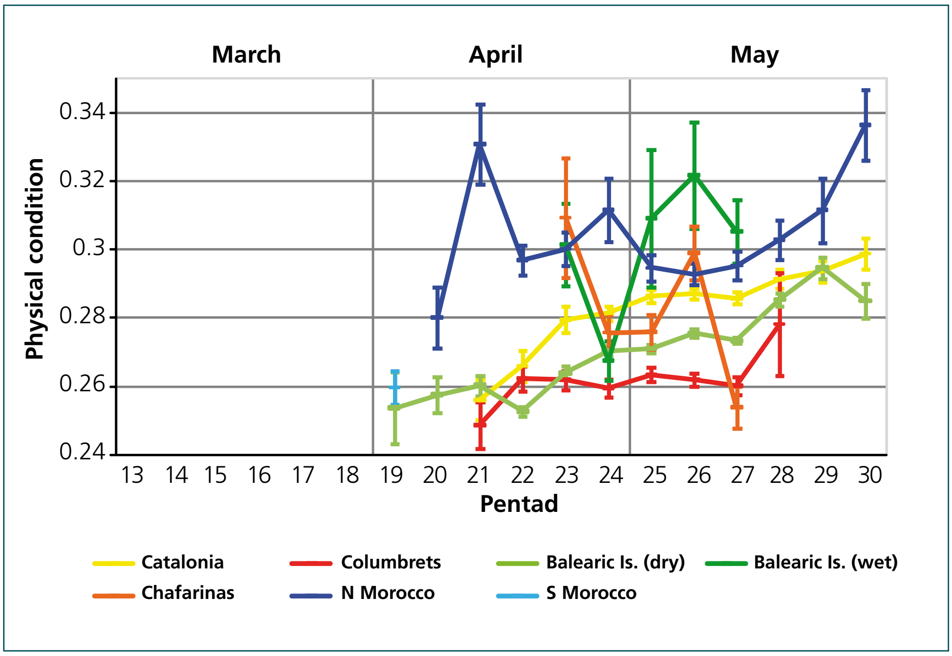


Figure 7. Temporal variation of physical condition according to area.

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

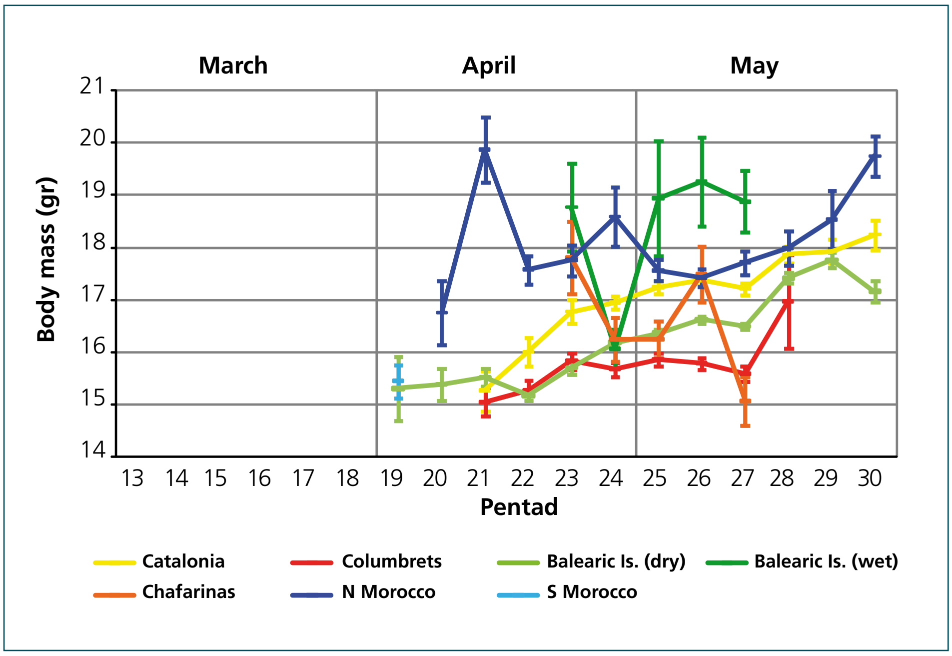
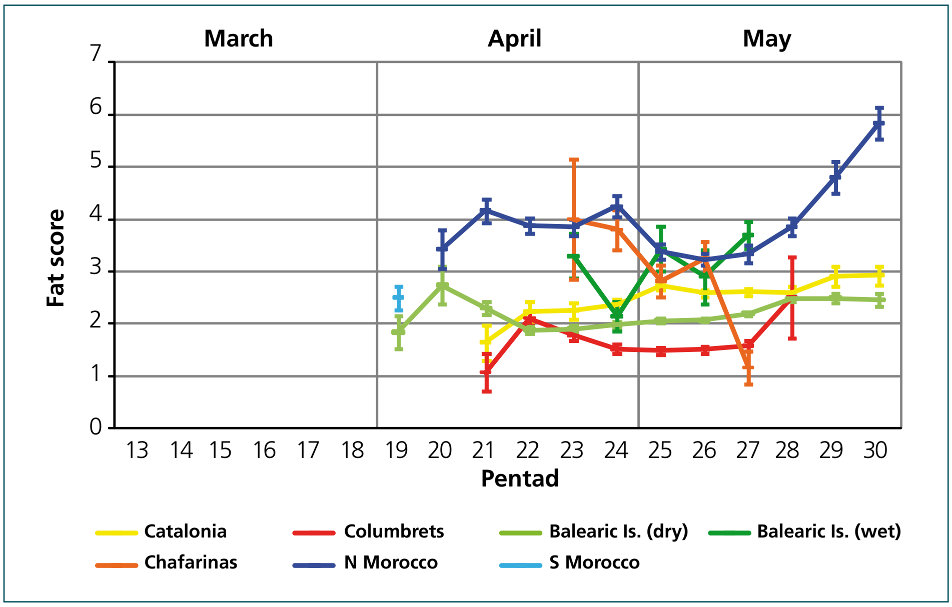


Figure 9. Temporal variation in fat score according to area.



Blackcap
Sylvia atricapilla

Germán López-Iborra & Joan Castany

Range

The Blackcap's breeding range covers parts of NW Africa and most of Europe eastwards to NW Iran and Kazakhstan (Cramp, 1992; Bairlein et al., 2006; Tellería et al., 1999; Shirihai et al., 2001). Eastern populations and those from N Europe, most of the Britain Isles and central Europe are fully migratory, while those from SW Europe and the Mediterranean Basin are only partially migrant; birds from the Atlantic and Mediterranean islands are largely sedentary (Cramp, 1992; Shirihai et al., 2001). Wintering grounds are in S and SW Europe, NW Africa and the Afrotropics (both in W and E Africa); long-distance movements to tropical Africa are undertaken by birds belonging to the most northerly and easterly populations, east and north from Britain and C Europe (Cramp, 1992; Shirihai et al., 2001).

At the study sites this species only breeds in the wet Balearics and at the Llobregat delta and Els Aiguamolls. The percentage of local breeding birds in the sample from the wet Balearics is high (*c.* 40%), but only very marginal from the Catalan sites (*c.* 1%). The species is a very common wintering bird in the wet Balearics, the S Moroccan oases and some sites in the dry Balearics (Formentera), but much less so at the Catalan study sites and on the smaller islands (where the large majority are migrants). On the smallest islands no or very few wintering birds are present (L'Illa de l'Aire, Conillera, Els Columbrets, L'Illa Grossa and Las Chafarinas).

Migratory route

Recoveries indicate that the main route used in spring follows a SW-NE axis, the exception being birds originating from Britain and parts of NW France, which seem to reach breeding areas following a more due N route NNE from Morocco and S Spain or even NNW from the Balearics (fig. 1). Most birds originate from S Britain, France and C Europe, the vast majority from west of the autumn migratory divide (*c.* 12ºE; Zink, 1973). These results agree with previous published data (Zink, 1973; Cramp, 1992; Wernham et al., 2002; Spina & Volponi, 2009). Although spring migration seems to take place across a broader front than in autumn (Cramp, 1992), a clear tendency to enter Europe through Morocco and SW Spain persists in spring, and most birds move through continental areas in a due NE direction in order to circumvent somewhat the Mediterranean Sea (present data; Zink, 1973; Cantos, 1992). In this respect, it is interesting to note that the species shows a significantly more due N average direction of movement in the Balearics / Els Columbrets than in Catalonia (11.19ºNE and 25.34ºNE, respectively). This pattern is due to the fact that the few recoveries from Britain and W France in NE Spain occur entirely on islands, suggesting that the proportion of birds following a NNW direction there is higher than in continental NE Spain (or, conversely, that in Catalonia a higher proportion follow the dominant NE direction).

An interesting recovery is of a bird ringed on coastal western Spain one spring and recovered at the other extreme of the country, 826 km to the WNW, the following spring. Data from Algeria reveals a misleading prevalence of SSE-NNW movements due to the concentration of recoveries in just one area on the Algerian coast (fig. 1); birds recovered there, in fact, originate from a wide area of Europe, to the NE, N and WNW (Zink, 1973; Spina & Volponi, 2009). The geographical variation in capture rates and frequencies shows that the species is widely trapped in all areas, reaching maximums at Els Aiguamolls in NE continental Spain and on Cabrera in the Balearics (fig. 2).

Phenology

Migration through the W Mediterranean starts before the beginning of the study period, usually by mid-February and even occasionally in late January (Murilllo & Sancho, 1969; Cramp, 1992; Finlayson, 1992; pers. obs.). During early March the influx of birds is still rather low and the main passage period occurs between late March and late April, peaking during the first half of this latter month (fig. 3). Data from Els Columbrets and L'Illa de l'Aire, where the species only occurs during migration, confirms this phenological pattern, with the sole difference that during March passage can be somewhat less marked. This is to be expected since most birds trapped in the study area are migrants and those wintering in the area mostly leave between February and early April; thus, numbers early in the season are, at worst, slightly overestimated. Patterns of passage are identical in Catalonia and the Balearics, while in N Morocco a lack of data from March prevents a rigorous comparison, although available published information indicates that migration tends to take place there earlier (Thévenot et al., 2003). At Gibraltar, migration peaks in late February and March (Finlayson, 1992). On Capri in the C Mediterranean peak passage occurs during the second half of April (Pettersson et al., 1990), suggesting later passage due to birds of more northern and eastern origin migrating through this area (Spina & Volponi, 2009). In SE Morocco trans-Saharan migrants seem to peak in the period late March to mid-April (Smith, 1968; Gargallo et al., unpubl.).

Males pass somewhat earlier than females (differences in median dates 6 and 5 days in adults and second-year birds, respectively), and adults also precede second-year birds by a few days (5 and 4 days earlier in males and females, respectively; fig. 3). Similar sex and age-related phenological differences have previously been documented for both spring migration and arrival on breeding grounds (Cramp, 1992), but were not found in other studies from Spain and Italy (*e.g.* Cantos, 1992; Spina et al., 1994; Rubolini et al., 2004). Recoveries show no trend in the latitude of capture north of the Pyrenees and the date of passage in the study area.

Biometry and physical condition

Mean values for third primary lengths vary little and range from 55.8 on Las Chafarinas to 57.4 in the wet Balearics (table 1), and in general are very slightly higher than in the C Mediterranean (mean 55.2, n = 896; Spina et al. 1993). Mean wing lengths vary from 73.5 in the dry Balearics to 75.1 in S Morocco. These values are distinctly higher than in local breeding populations from continental Spain and the Balearics (Cramp, 1992; Shirihai et al., 2001; ICO, 2010), further indicating that local birds contribute little to the sample. In fact, figures are similar to those reported in W Europe, the main area of origin of birds trapped in the study area (see above), but lower than in the E Mediterranean, the region through which the larger eastern populations migrate (Cramp, 1998; Morgan & Shirihai, 1997). There is a common decreasing trend in third primary length during the season (fig. 6). Since recoveries do not show any trend regarding the date of passage and their latitude of origin, this tendency may respond to the later passage of second-year birds. Sexual differences in third primary length are very small or non-existent, but second-year birds do have shorter wings than adults (Shirihai et al., 2001; ICO, 2010), a difference that may suffice to explain the observed pattern. On the Tyrrhenian islands, there is a different trend in third primary length, possibly caused by the later passage of larger-sized northern birds (Spina et al., 1993).

Fat reserves are significantly higher in N Morocco and in the dry Balearics than in Catalonia and on Els Columbrets (table 1, fig. 9). Physical condition is similarly higher in the dry and wet Balearics in comparison to Catalonia and Els Columbrets, although the significantly highest values occur in N Morocco, where birds are in better condition than in the south of the country (fig. 8). Fat and physical condition show an overall decreasing trend during the season.

Mean body mass varies from 17.5 on Els Columbrets to 19.7 in N Morocco and, in accordance with fat and physical condition, also shows an overall steady decrease during the migratory period (fig. 8). A similar decrease in body mass and also in fat is reported from the C Mediterranean (Spina et al., 1993; Spina & Volponi, 2009). Averages are significantly higher in the Balearics (both areas) than on Els Columbrets and in Catalonia, although the highest values for all areas are obtained in N Morocco. Mean body mass, fat and physical condition in S Morocco are similar to those of Catalonia, Els Columbrets and the Balearics. At Els

Aiguamolls, one of the sites with the highest number of captures, birds are in markedly (and significantly) poorer condition (fat, body mass) than in the rest of Catalonia (fig. 4). This difference is difficult to explain, but may reflect a higher number of birds arriving directly from sea or, more probably, the negative effects of the area's prevailing northerly winds. When excluding data from this site, body mass in Catalonia is significantly higher than in the Balearics/Els Columbrets (mean 18.9, n = 1,459).

On the Tyrrhenian islands mean body mass is slightly lower than in the Balearics/Els Columbrets (mean 17.0, n = 896; Spina et al., 1993). The average in N Morocco is identical to that reported from N Tunisia (19.7, n = 44; Waldenström et al., 2004), but higher than at Kaifiene, also in N Morocco (17.9, n = 26; Smith ,1979). At Gibraltar, excluding local breeding birds, *c.* 80% of birds have large amounts of fat (fat bulging at tracheal pit; Finlayson, 1981) and average body mass is very close to that in N Morocco (mean 19.9, n = 255; data from March-April; Langslow, 1976). In Seville, 150 km to the north, body mass is still higher (mean 22.3, n = 97; Rodríguez, 1985). Averages from observatories in S Britain (18.1, n = 578; Langslow, 1976) and the Netherlands (18.0, n = 8; Cramp, 1992) are very similar to those from Catalonia and the dry Balearics, although somewhat lower than in the former area (when excluding Els Aiguamolls). The average obtained from S Morocco is distinctly higher than from the nearby but much smaller oases of Defilia (14.1, n = 181; Ash, 1969) and Merzouga (15.6, n = 33; Gargallo et al., unpubl.). This difference most probably reflects the fact that at the latter two sites most of the captures correspond to trans-Saharan migrants, while in our two study sites, both located in large oases, a higher proportion of wintering birds is present. In fact, averages at Defilia and Merzouga are roughly similar to those reported in S Israel in the E Mediterranean, also at the northern fringe of the desert (mean 15.4, n = 3,585; Morgan & Shirihai, 1997).

According to available data, birds trapped just after crossing the Sahara are in worst condition, with an average body mass distinctly lower than during the breeding season (Langslow, 1976; ICO, 2010) and *c.* 22-29% lower than in birds captured in Senegal just before crossing the Sahara (mean 20.0, n = 273; March-May data; Ottoson et al., 2001). This picture is obscured when looking at data from the larger oases, where the species is a very common wintering bird (Thévenot et al., 2003; pers. obs.). Wintering or migrating birds obtain the highest energetic reserves in N Morocco and S Spain, suggesting that at least a substantial part of these birds will undertake long-distance movements northwards (present data; Langslow, 1976; Finlayson, 1981; Rodríguez, 1985). Interestingly, the gain in mass in these areas is equivalent or even higher to that shown by trans-Saharan migrants in Senegal: in both cases birds pass from mid-winter masses of *c.* 17-18 g to *c.* 20 g (*c.* 22 in Seville) in spring (Langslow, 1976; Rodríguez, 1985; Ottoson et al., 2001). Averages are still high on L'Illa Grossa (mean 21.0, n = 7; fig. 4), *c.* 300 km south of Catalonia; averages of *c.* 19 g at most Catalan sites and of *c.* 18 in S Britain and C Europe indicate a progressive depletion of reserves along the continental route and once more indicate that S Spain and N Morocco are key areas for fattening up. Other than at Els Aiguamolls, body condition in continental NE Spain is distinctly higher than in the insular sites (Balearics/Els Columbrets), suggesting that birds crossing the sea have to tackle a more demanding route in terms of energy consumption.

Stopover

The percentage of retraps is low in all areas and the mean stopover length ranges from 3 to 7 days, with no significant differences between areas (table 2, fig. 5). Birds remaining in Catalonia and the dry Balearics are in poorer condition when first captured than those not trapped again, indicating that a higher proportion of birds in poorer condition end up staying at these sites. Moreover, in these areas and on Els Columbrets birds have fairly obvious negative fuel deposition rates; a similar pattern is found in the Balearics but is not significant. The only area where birds show a positive fuel deposition rate is in N Morocco, although there too it is not significant.

As indicated by biometrical data, these results point to the unsuitability of NE Spain and the Balearics/Els Columbrets as stopover areas, since most birds that need to stop seem to end up staying unsuccessfully at these sites. The low number of retraps and inconclusive fuel rates obtained in N Morocco indicate that, although birds certainly fatten up in this area, most mass gain takes place outside the specific study sites. These ringing sites apparently mostly trap birds already on active migration.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	4,121	73.6 ± 2.1 (61.0-81.0)	56.6 ± 1.8 (50.0-63.0)	17.8 ± 2.1 (11.8-26.0)	2.9 ± 1.6 (0-8)
Columbrets	542	74.1 ± 2.4 (60.0-81.5)	56.4 ± 2.0 (50.0-63.0)	17.5 ± 2.5 (12.0-27.0)	2.7 ± 1.7 (0-8)
Balearics (dry)	4,381	73.5 ± 2.2 (59.0-81.0)	56.2 ± 1.9 (50.0-63.0)	17.9 ± 2.7 (11.4-29.3)	3.3 ± 1.7 (0-8)
Balearics (wet)	154	73.7 ± 2.2 (69.0-80.0)	56.6 ± 1.9 (51.5-62.5)	18.5 ± 2.1 (12.9-24.1)	3.3 ± 1.5 (0-7)
Chafarinas	5		55.8 ± 0.8 (55.0-57.0)	18.4 ± 1.7 (16.5-21.1)	3.6 ± 2.2 (0-5)
N Morocco	283	73.8 ± 2.3 (59.5-80.0)	56.6 ± 1.8 (51.0-62.0)	19.7 ± 2.6 (13.0-26.0)	3.4 ± 1.8 (0-7)
S Morocco	31	75.1 ± 2.0 (72.0-79.0)	56.6 ± 1.6 (54.0-59.0)	17.5 ± 1.4 (15.8-20.3)	2.9 ± 1.4 (1-5)

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	-0.17 ± 0.07 (269)	-1.04 ± 0.78 (16)	-0.40 ± 0.11 (220)	-0.26 ± 0.27 (6)		0.29 ± 0.37 (16)
Retraps >1 day	-0.06 ± 0.05 (184)	-0.4 8 ± 0.30 (8)	-0.10 ± 0.07 (134)	-0.17 ± 0.25 (5)		0.25 ± 0.38 (13)

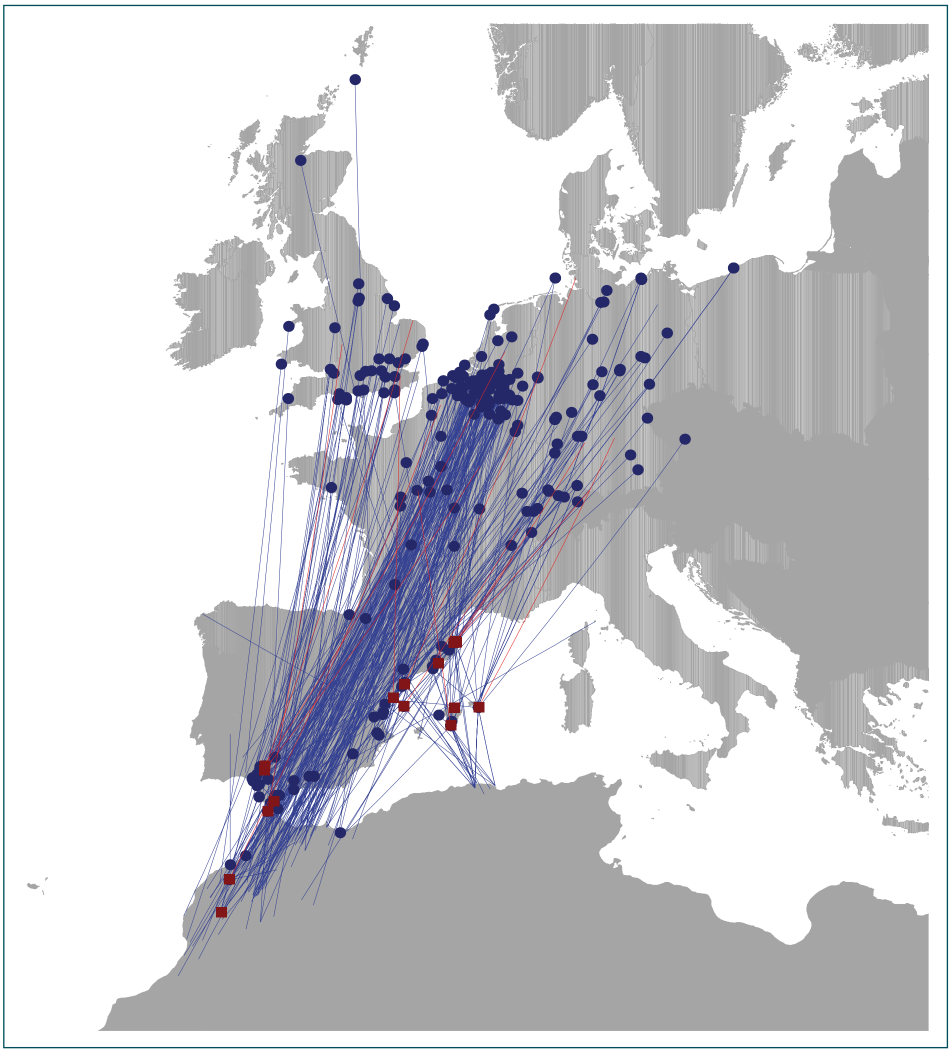


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

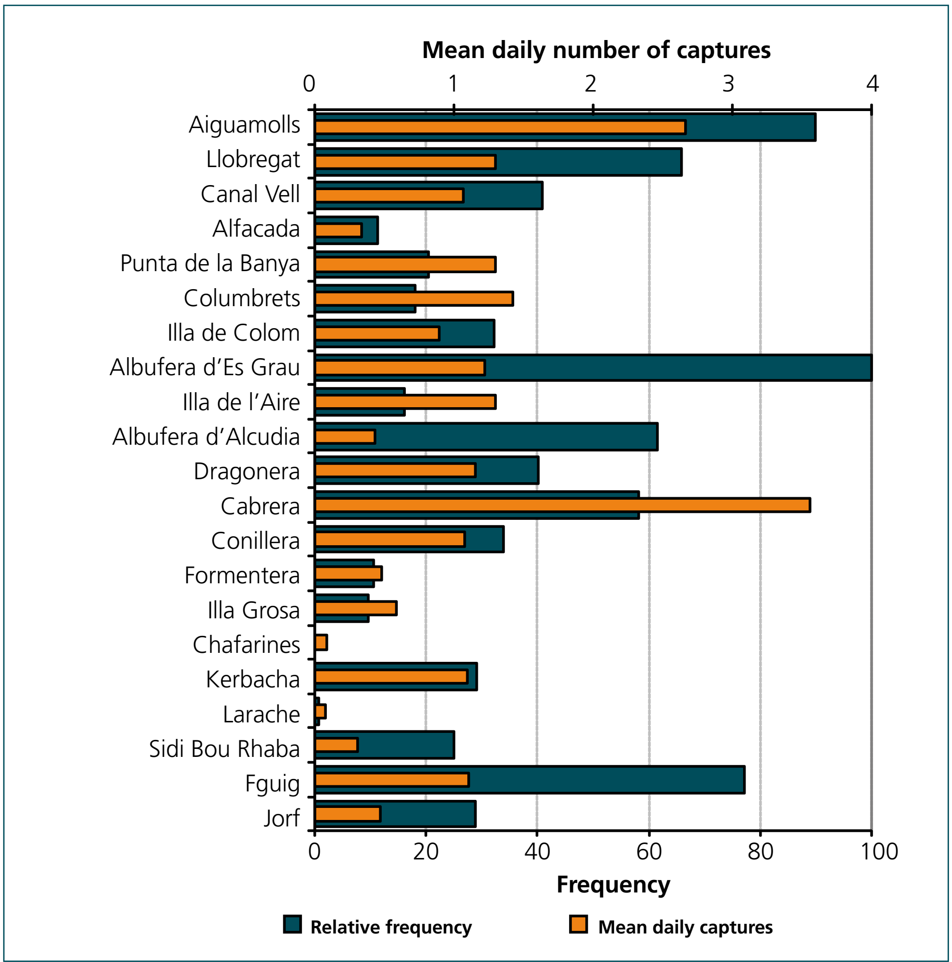


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

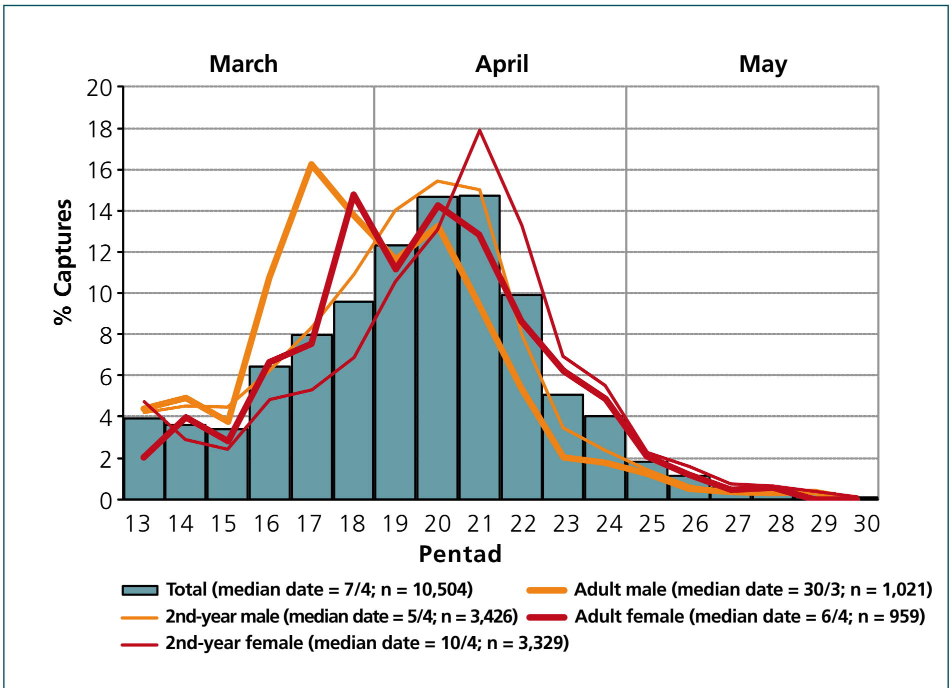


Figure 3. Frequency of captures during the study period.

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

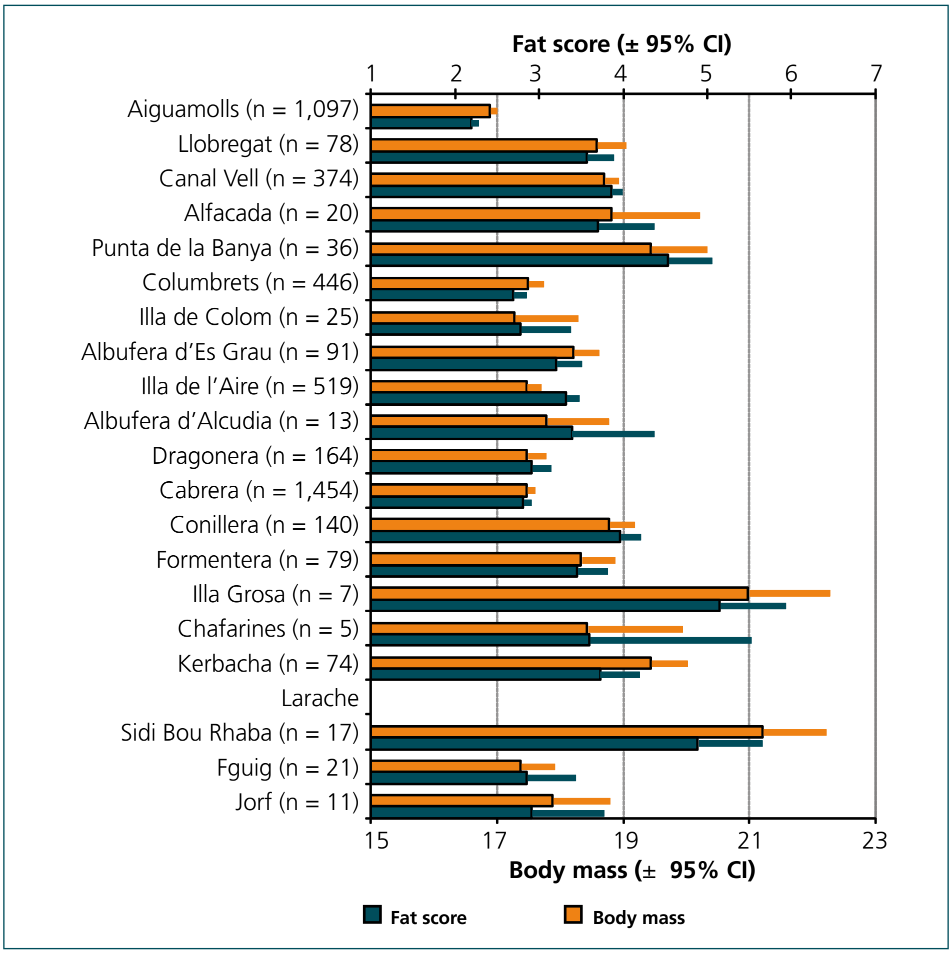
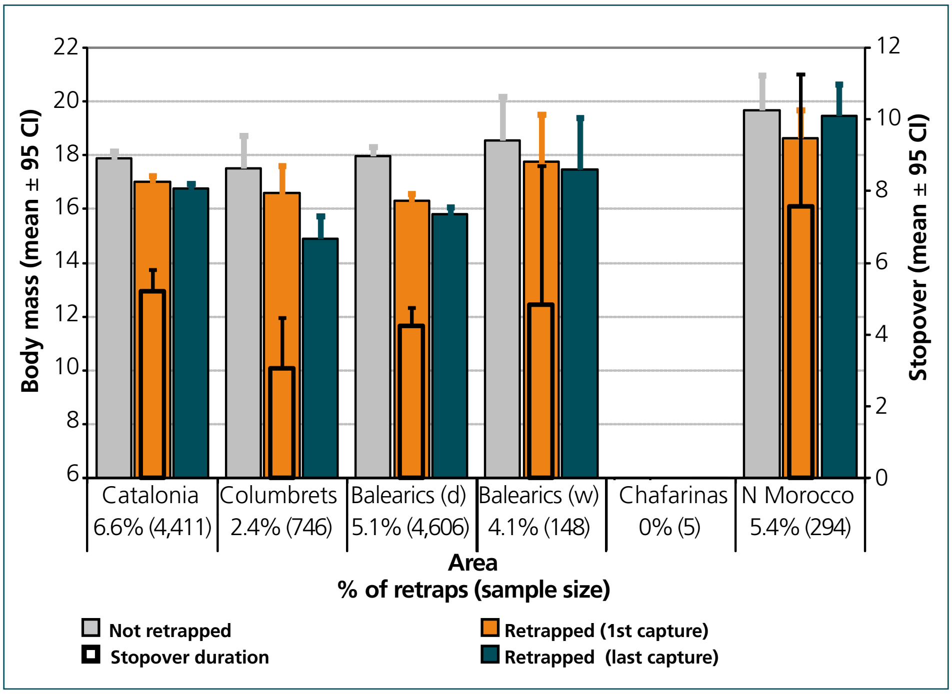


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



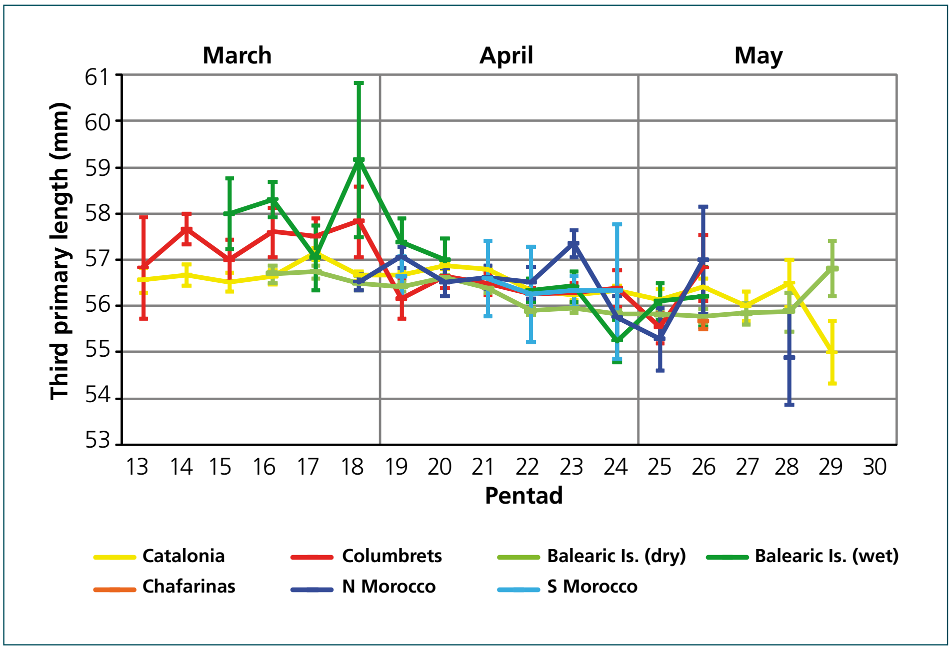


Figure 6. Temporal variation of third primary length according to area.

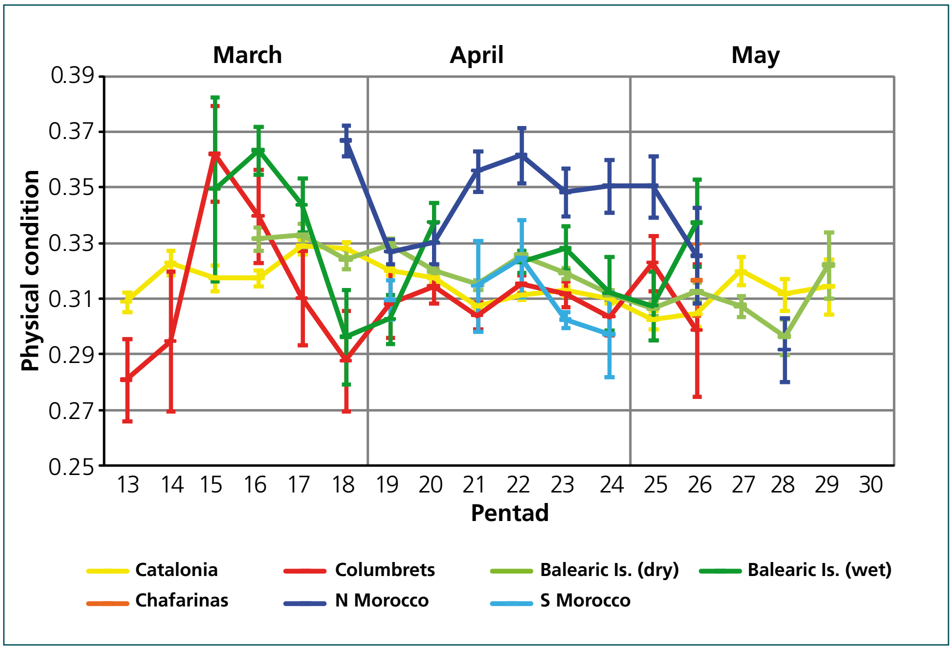


Figure 7. Temporal variation of physical condition according to area.

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

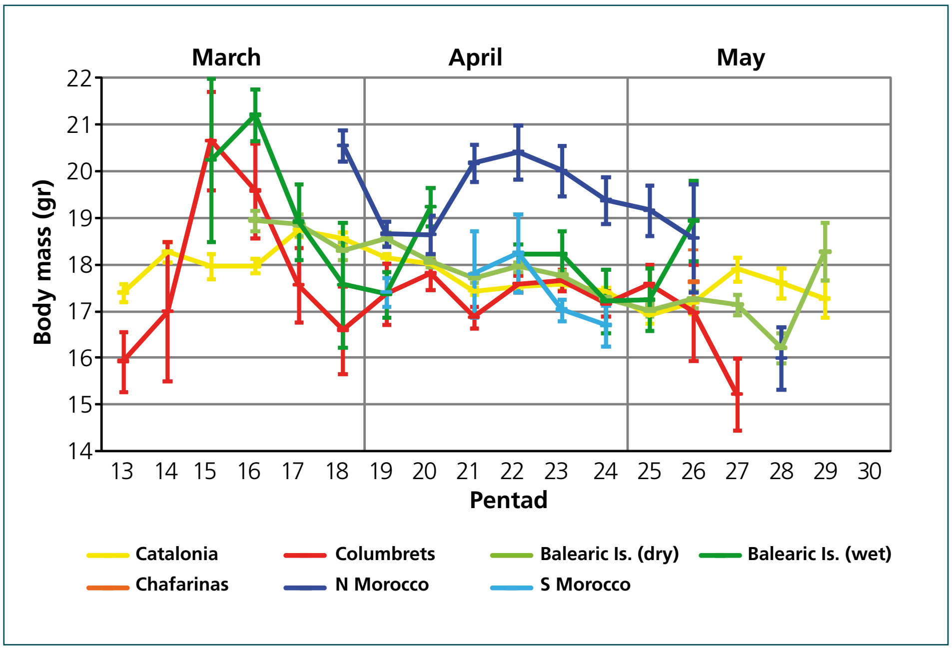
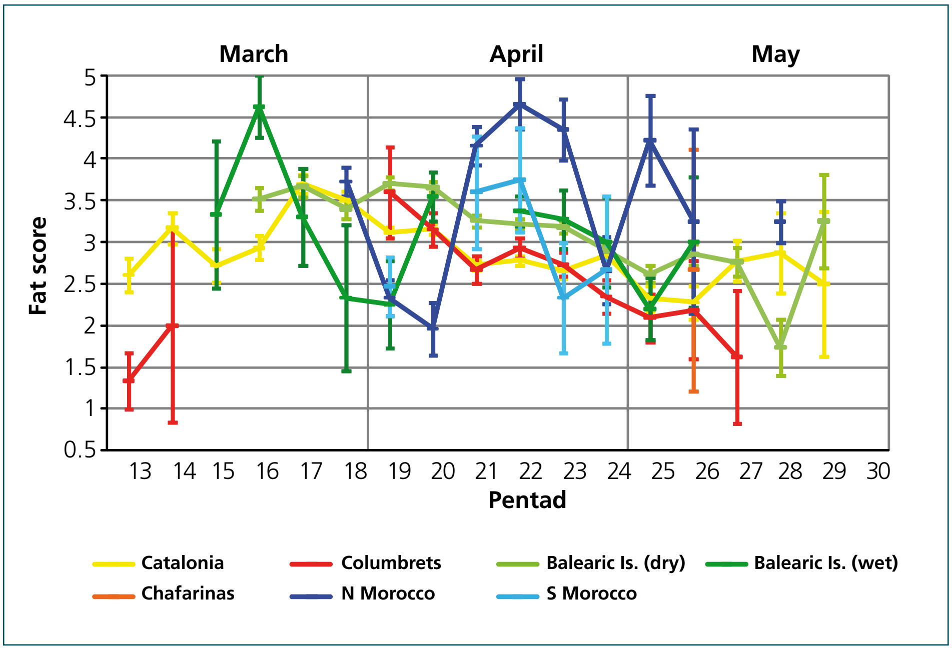


Figure 9. Temporal variation in fat score according to area.



Western Bonelli's Warbler *Phylloscopus bonelli*

Carles Barriocanal & David Robson

Range

Western Bonelli's Warbler breeds at middle and lower-middle latitudes in W and C Europe, from France, S Germany, W Austria and Czechoslovakia, south to Morocco and Tunisia, including the Iberian Peninsula, Italy, Corsica, Sicily and W former Yugoslavia (Cramp, 1992). It is a long-distance migrant that winters in the Sahel, from S Mauritania and Senegal east to the Lake Chad basin (Cramp, 1992). It does not breed at any of the ringing sites.

Migratory route

There are very few recoveries of Western Bonelli's Warbler (Cramp, 1992) and only three from the study area (fig. 1). One individual captured in April in SW Spain was recaptured a year later in N Morocco; another bird also captured in April (on Els Columbrets) was recaptured in May the following year in SW France; and, finally, a bird recaptured after a short movement in continental Spain was probably a local breeder.

The number of captures on islands is far greater than on the mainland, apparently due to an attraction effect (fig. 2). This effect is particularly clear when comparing the greater number of captures on Conillera than on Formentera: these two sites are less than 35 km apart, but the former is a small island with little vegetation and the latter a much larger one with much more suitable habitat. Captures tend to be comparatively higher in W and SW Balearic sites (*e.g.* Conillera and Dragonera) than in more eastern ones (*e.g.* L'Illa de l'Aire, Cabrera and Colom). This pattern and the notable number of captures from Els Columbrets and L'Illa Grossa agree with the overall migratory route suggested for this species by Pilastro et al. (1998), that is, birds enter Europe following a marked SW–NE path along the eastern coast of the Iberian Peninsula. There are relatively few captures at Moroccan sites, although this warbler is more common and widespread in NW Africa in spring than in autumn (Cramp, 1992; Thévenot et al., 2003).

Phenology

Apart from the arrival of some very early individuals in mid-March, the main passage period takes place from late March onwards, with a peak at the end of April and a steep decrease thereafter during May (fig. 3). This pattern is similar in all three study areas (N Morocco, Catalonia and the Balearics/Els Columbrets). Overall, passage resembles the pattern described for birds on spring migration in the Gibraltar area (Finlayson, 1992) and La Camargue (S France) (Blondel & Isenmann, 1981). Along the Atlantic coast of Morocco passage is somewhat earlier and is occasionally observed in late February in the south (Thévenot et al., 2003), although usually not until mid-March onwards in the SE (Gargallo et al., unpubl.).

Biometry and physical condition

Mean values for third primary lengths range from 45.9 (Las Chafarinas) to 49.2 (Catalonia; table 1). Mean values for wing lengths vary from 60.8 (N Morocco) to 63.3 (Catalonia), within the values reported in spring from other sites in W Europe (Cramp, 1992). The third primary length shows a decreasing trend over time (fig. 6), reflecting the differential migration of sexes: shorter-winged females migrate later than males. There is no clear latitudinal gradient in body mass or fat score, and there seems to be no great differences between sites and habitats (table 1, fig. 4). Mean fat scores are generally low, between 2.0 and 2.3 at all the sites except Els Columbretes (0.9) and Las Chafarinas (1.8). Body mass tends to decrease with time, though only significantly so in Els Columbrets (fig. 8). Fat and physical condition show a slight but significant decreasing trend on Els Columbrets but a positive one in the dry Balearics (figs. 7, 9). Birds captured on Els Columbrets, the most isolated island and the most distant from N Africa, have the poorest body condition of all, as well as the lowest fat reserves and body mass, a consequence of the progressive depletion of birds' energetic reserves during sea crossings.

The few captures from N Morocco have a mean body mass similar to that of Catalonia and the dry Balearics and to those reported from S Morocco (mean 7.2, n = 242; Ash 1969; Gargallo et al., unpubl.). Finlayson (1981) obtained a somewhat lower value (7.0, n = 34) from birds grounded on Gibraltar in spring. All these values are only marginally higher than those recorded in Catalonia during the breeding season (mean 7.1, n = 157; ICO, 2010), indicating that after arriving in N Africa this species does not change mass to any great degree. Migration therefore probably takes place in rather short bouts (and brief stopovers; see below), at least over continental areas. An exception may be birds reaching Europe after crossing long stretches of the Mediterranean. In these cases, birds surely leave N Africa with more reserves than the average birds in N Morocco, otherwise they would be captured on the Balearic Islands with obviously lower mean body masses than those given here.

Stopover

Mean stopover length is rather low (*c.* 2-2.5 days; table 2, fig. 5), indicating that birds do not tend to stop for more than one day at the study sites. Birds staying in Catalonia show some degree of mass gain while those on Els Columbretes and in the dry Balearics do not present any clear trend; these differences, however, are not significant. In the dry Balearics birds staying in the area have significantly lower initial body mass than those not trapped again. This pattern suggests that those remaining on the islands tend to be birds that are unable to continue migration due to poor physical condition.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	139	63.3 ± 2.6 (58.0-69.5)	49.2 ± 2.4 (43.0-55.0)	7.3 ± 0.8 (5.5-9.1)	2.4 ± 1.2 (0-6)
Columbrets	220	63.0 ± 2.8 (56.0-69.0)	48.7 ± 2.4 (43.5-55.0)	6.6 ± 0.8 (5.0-9.4)	0.9 ± 0.9 (0-4)
Balearics (dry)	705	62.6 ± 2.6 (57.0-69.0)	48.3 ± 2.3 (43.0-54.0)	7.1 ± 0.8 (4.6-10.1)	2.1 ± 1.1 (0-7)
Balearics (wet)	2	63.0 ± 0.0 (63.0-63.0)	49.0 ± 0.0 (49.0-49.0)	7.5 ± 0.5 (7.2-7.9)	3.5 ± 0.7 (3-4)
Chafarinas	9		45.9 ± 2.6 (43.0-51.5)	6.9 ± 0.7 (6.2-8.3)	1.8 ± 1.2 (0-4)
N Morocco	11	60.8 ± 1.6 (57.0-63.0)	47.3 ± 2.5 (44.0-54.0)	7.3 ± 0.6 (6.4-8.4)	2.4 ± 1.4 (0-4)
S Morocco	2	61.3 ± 1.1 (60.5-62.0)	47.5 ± 2.8 (45.5-49.5)	6.4 ± 0.5 (6.0-6.7)	1.0 ± 0.0 (1-1)

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	0.10 ± 0.21 (10)	-0.03 ± 0.23 (6)	-0.05 ± 0.09 (39)			
Retraps >1 day	0.16 ± 0.35 (4)	0.02 ± 0.35 (3)	0.05 ± 0.09 (23)			

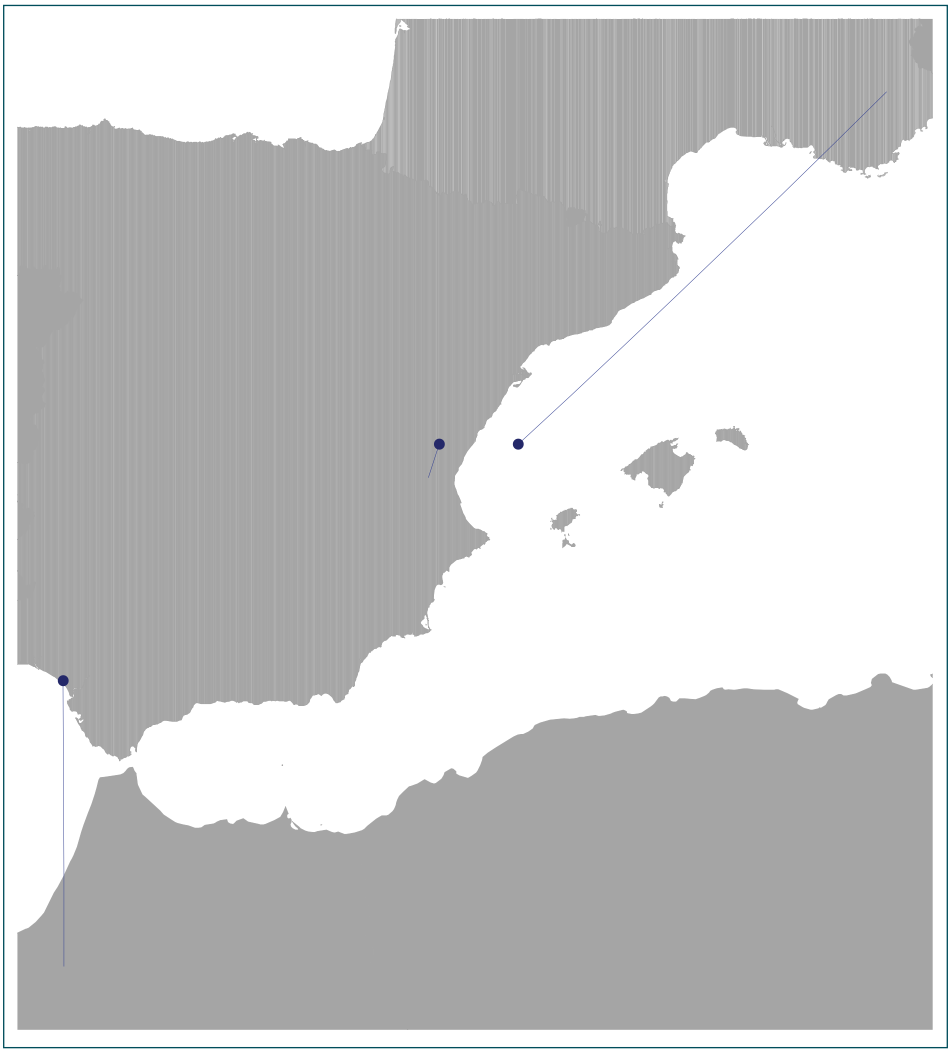


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

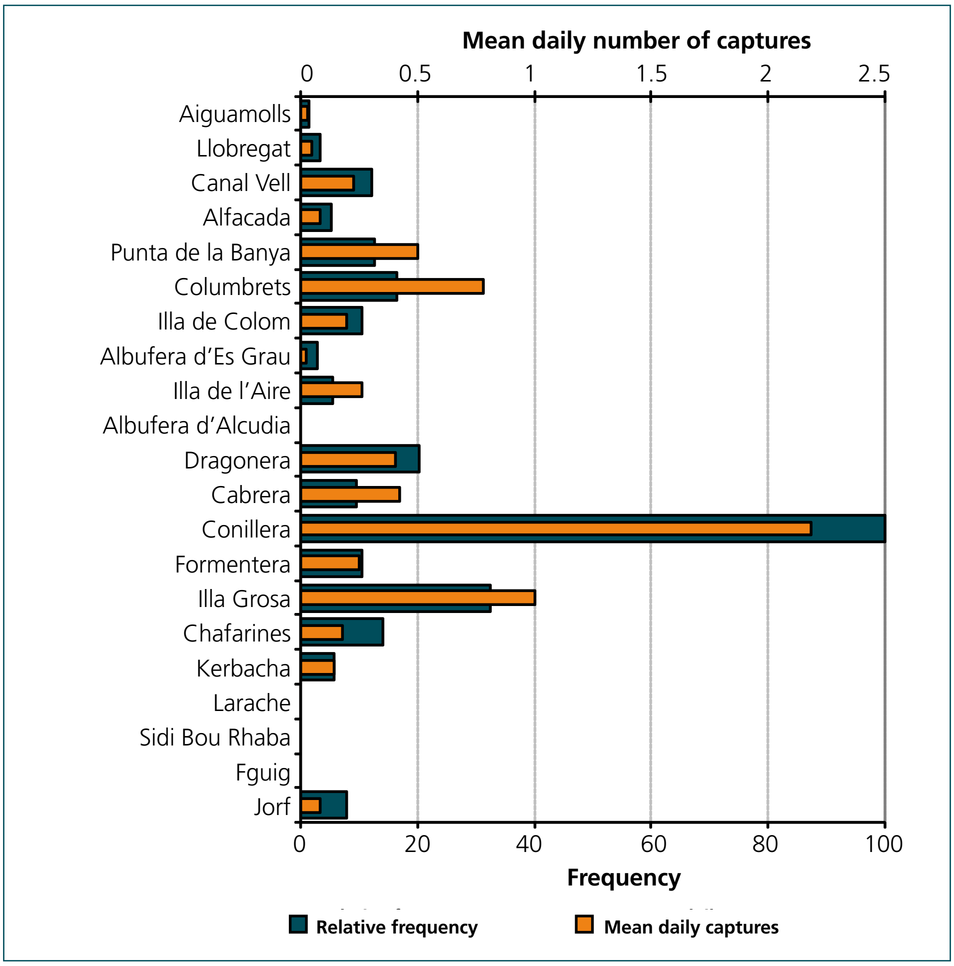


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

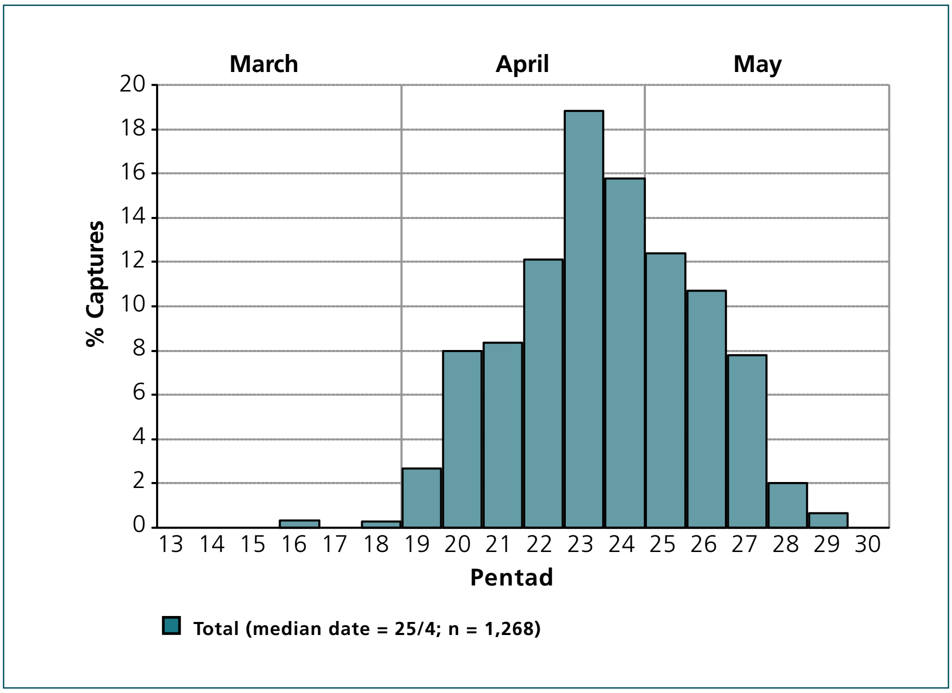


Figure 3. Frequency of captures during the study period.

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

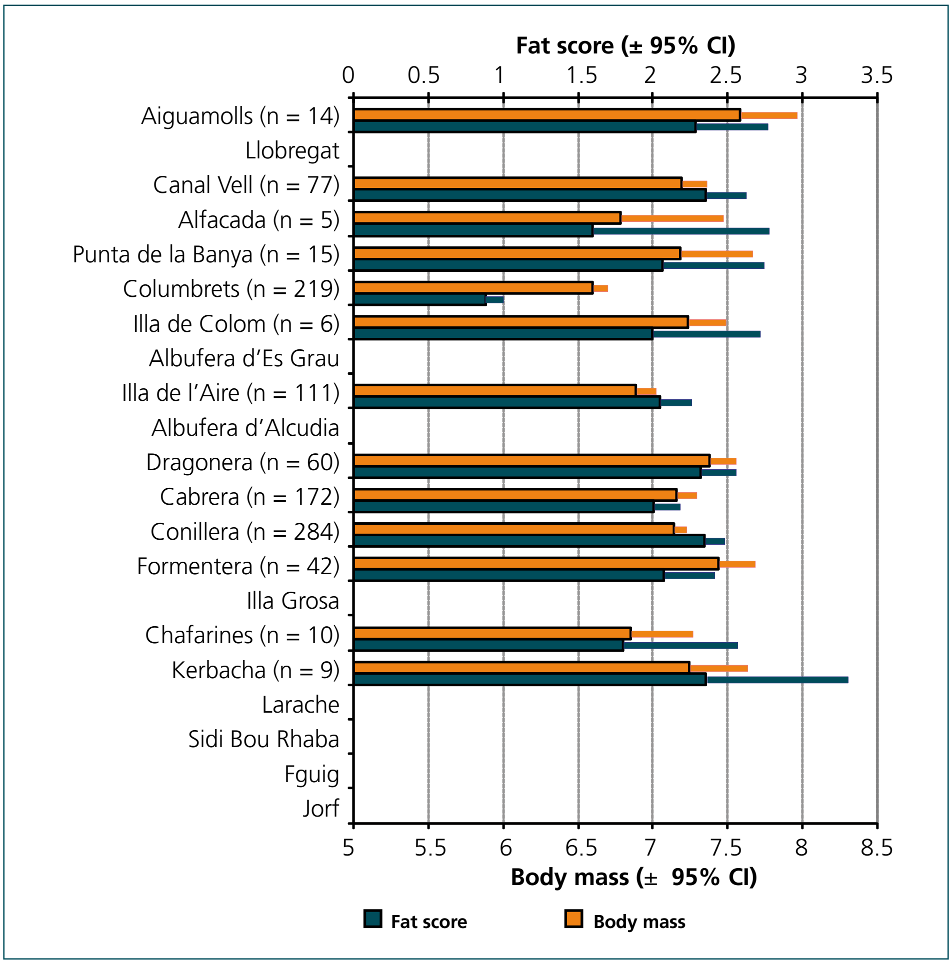
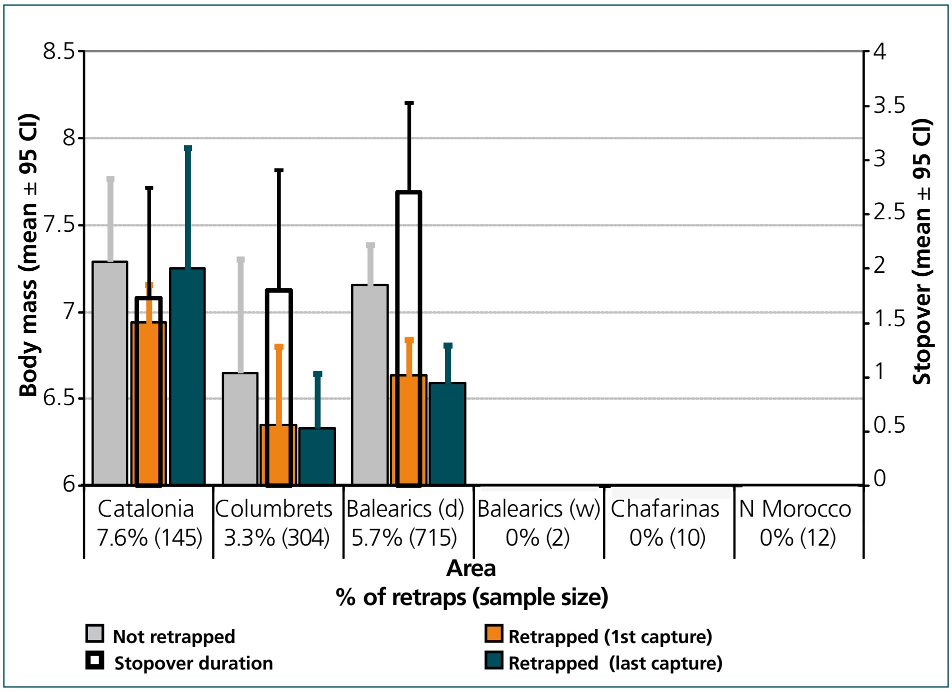


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



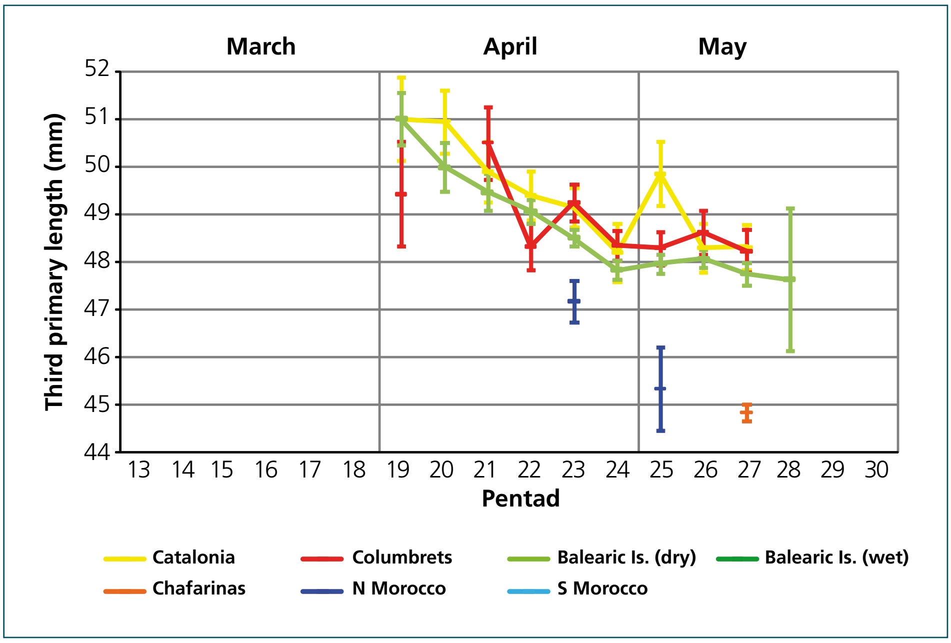


Figure 6. Temporal variation of third primary length according to area.

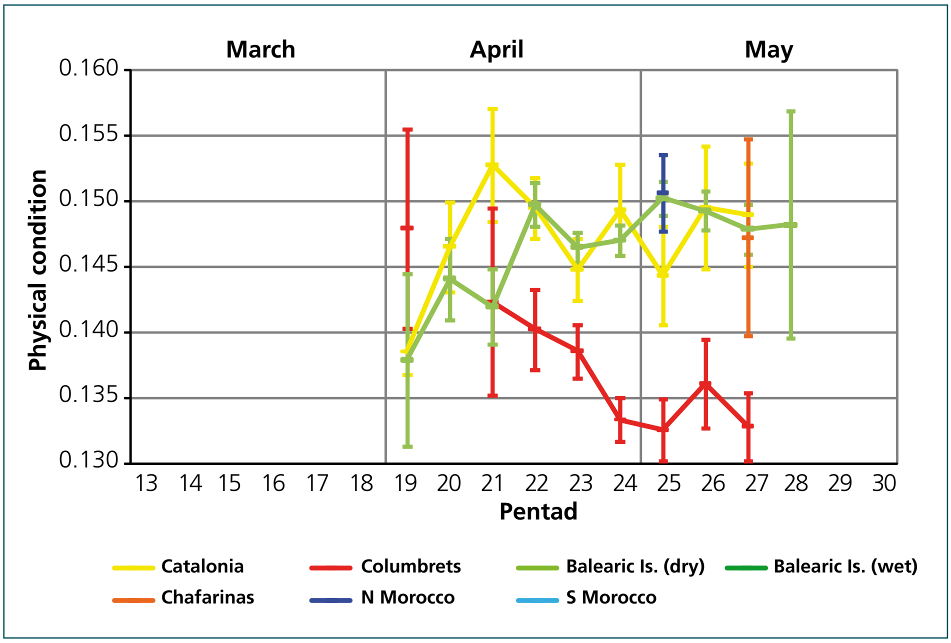


Figure 7. Temporal variation of physical condition according to area.

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

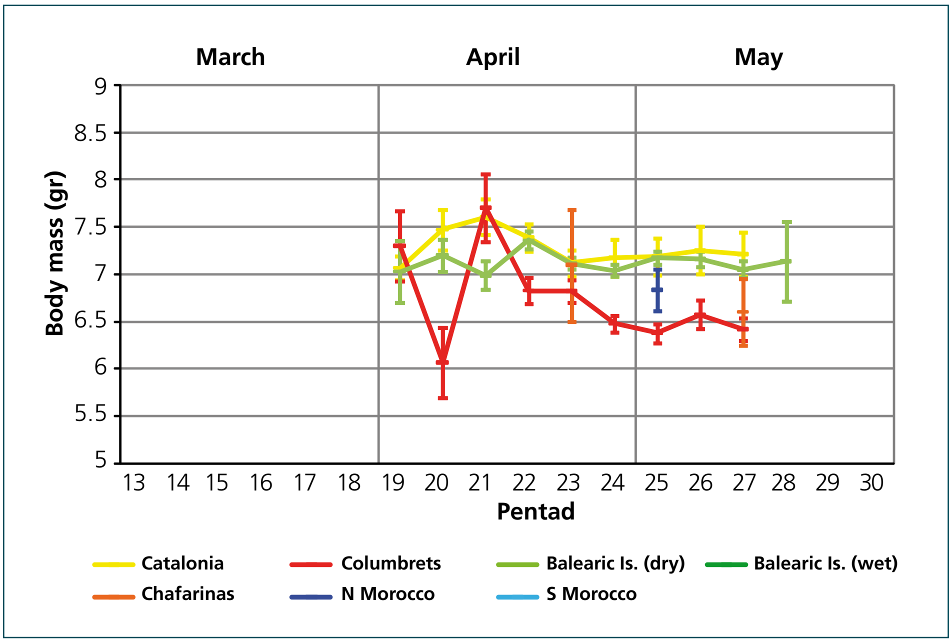
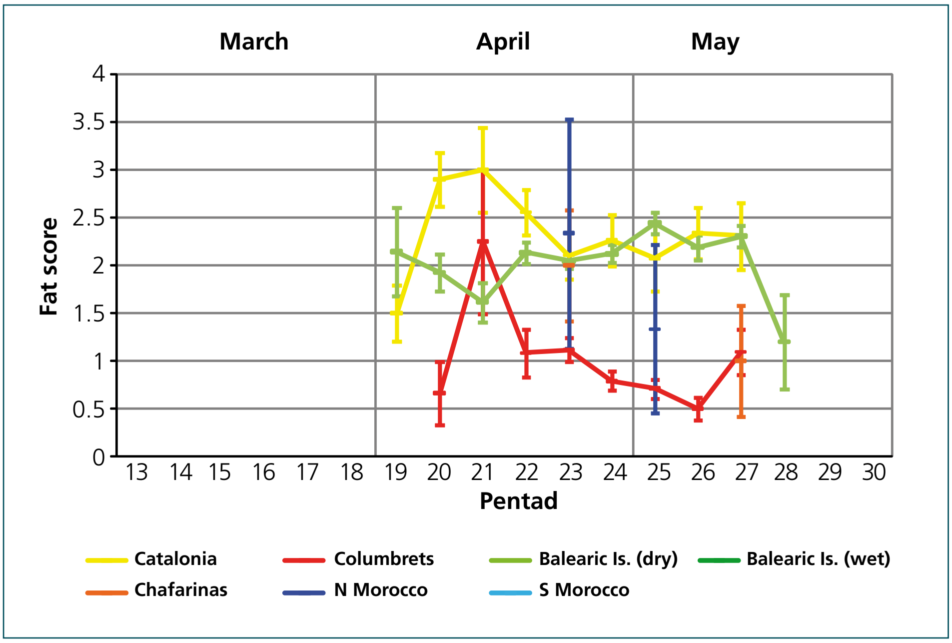


Figure 9. Temporal variation in fat score according to area.



Wood Warbler

Phylloscopus sibilatrix

Carles Barriocanal & David Robson

Range

The Wood Warbler breeds in the temperate and boreal W Palearctic north of the Mediterranean and the Black Sea, from the British Isles and Scandinavia eastwards to W Siberia (Cramp, 1992). It winters in sub-Saharan Africa from Sierra Leone and S Guinea east to W Uganda and south to *c.* 6ºS (Cramp, 1992). It does not breed in the study area.

Migratory route

In spring, this species mainly follows a S-N flight direction, migrating from tropical Africa to Europe through the C Mediterranean (Pilastro et al., 1998; Spina & Volponi, 2009), using a more westerly and direct route than in autumn (Zink, 1973; Glutz von Blotzheim & Bauer, 1991; Cramp, 1992). As expected, the species is much commoner in the study area during spring than in autumn (Clavell, 2002; Thévenot et al., 2003; ICO, 2010), being more abundant further east and particularly so in the Balearics (fig. 2). It is also rather common in NE Morocco, suggesting that some birds must follow more SW-NE routes to European breeding grounds, as indeed is shown by the recoveries discussed here (fig. 1) and others reported by Zink (1973) and Spina & Volponi (2009). These movements may in fact be commonplace given the abundance of this species in Morocco and Algeria during spring (Isenmann & Moali, 2000; Thévenot et al., 2003).

In contrast with the patterns shown by Willow and Western Bonelli's Warblers, the largest relative frequencies and highest raw number of captures are recorded at well-vegetated sites with some forested areas such as L'Albufera d'Es Grau and L'Alcúdia in the Balearics, and Kerbacha in N Morocco (fig. 2). This species thus seems to be much more selective in terms of habitat requirements and less inclined to use isolated and sparsely vegetated islands as provisional or emergency stopover sites. This selectivity may have relevant conservation implications for this declining species (BirdLife International, 2004).

Phenology

Passage begins at the very end of March, with a peak between the end of April and early May (fig. 3). The overall pattern is similar to that reported on the Tyrrhenian islands (Rubolini et al., 2005) and in La Camargue (Blondel & Isenmann 1981). In the Balearics/Els Columbrets captures occur somewhat later than in Catalonia and Morocco (median date *c.* 7 days later). The frequency distribution of third primary lengths clearly depicts a differential migration of sexes: males (distinctly larger; Cramp, 1992) migrate from late March to the second half of April and females mostly from mid-April onwards (fig. a). It is unknown whether this difference is a consequence of males departing earlier or travelling faster, although in the C Mediterranean male Wood Warblers seem to undertake shorter stopovers than females (Holmgren & Engström, 2006). The arrival of males at breeding grounds clearly takes place ahead of females by *c.* one week (Cramp, 1992).

Biometry and physical condition

Mean values for third primary lengths range from 58.4 (dry Balearics) to 59.8 (wet Balearics; only one in S Morocco 60.5; table 1), similar to the values reported from the C Mediterranean (mean 58.7, n = 14,046; Messineo et al., 2001). Mean wing lengths vary from 75.1 (dry Balearics) to 76.8 (Els Columbrets, one in S Morocco 78.0), similar to values reported in spring from C Europe and the C and E Mediterranean (Cramp, 1992; Morgan & Shirihai, 1997; Messineo et al., 2001; Waldenström et al., 2004). The third primary length shows a marked tendency to decrease over time (fig. 6), as is also found in the C Mediterranean (Messineo et al., 2001) and reflects the differential migration of the sexes.

Mean fat score values range between 0.7 (Els Columbrets) and 2.8 (N Morocco). Figures from the Balearics are slightly higher than those recorded on the C Mediterranean islands (overall mean 1.4, n = 13,533; Messineo et al., 2001). Birds trapped in N Morocco have the highest fat loads, apparently similar to those recorded in N Tunisia (Waldenström et al., 2004). Mean fat and physical condition are significantly lower on Els Columbrets than in other areas and is higher in N Morocco than on Els Columbrets and the dry Balearics. Overall, fat shows a slight but significant tendency to increase over time (fig. 9, and is paralleled by an improvement in physical condition (fig. 7). This tendency indicates that birds migrating early (mostly males) are in poorer condition than those migrating later (mainly females). This pattern may reflect the fact that feeding conditions improve as the season progresses or that females, with less of a need to migrate faster and earlier than males, can proceed in a less demanding way (*e.g.* making longer stopovers; Holmgren & Engström, 2006).

Mean body mass varies from 8.2 (Els Columbrets) to 9.7 (N Morocco) and shows a slight but significant overall trend to increase during the season (fig. 8), contrary to the tendency observed on the Tyrrhenian islands (Spina et al., 1993). Birds are heavier in the wet Balearics and, especially, in N Morocco. Mean values in the Balearics are higher than those reported from the islands of the C Mediterranean (8.3, n = 14,428; Messineo et al., 2001), where birds show similar mass to Els Columbrets, the most isolated island in our study area. Mean body mass at Kerbacha (NE Morocco) is somewhat higher than in N Tunisia (mean 9.3, n = 53; Waldenström et al., 2004). We trapped only one bird in S Morocco, but good datasets from this same area report means of 8.4 (n = 43; Ash, 1969) and 8.8 (n = 40; Gargallo et al., unpubl.). Spring data from Souss Massa in SW Morocco (mean 8.2, n = 10; D. Robson & E. Durany, unpubl. data) and from S Israel (mean 8.5, n = 51; Morgan & Shirihai, 1997) are also similarly low.

Birds from N Morocco are on average in better condition, being *c.* 9% heavier than in the dry Balearics, *c.* 5% heavier than in Catalonia and *c.* 7-19% heavier than in S Morocco. This result suggests that this species is able to regain part of the energetic reserves lost when crossing the Sahara while in Morocco. The relevance of this region as a reliable stopover area is further supported by the abundance of this species in NW Africa during spring (Isenmann & Moali, 2000; Thévenot et al., 2003). In Catalonia birds are only in slightly poorer body condition than in N Morocco suggesting that once in continental Europe the species is able to regain some mass and continue migration by means of short bouts of flying. Birds passing through Els Columbrets and the Balearics are, however, in distinctly poorer condition, a sign of the effort involved in crossing the sea. Birds trapped in the wet Balearics are significantly heavier and have larger fat reserves than those from more isolated and sparsely vegetated sites (dry Balearics), suggesting that birds stopping at these latter sites include a higher proportion of birds who need to do so for energetic reasons. Birds stopping at wetlands may also gain mass faster and include a larger proportion of birds already on land for a few days (either at the site itself or in surrounding areas), which may also lead to better average body condition (see below also). The higher body mass and fat reserves recorded in the Balearics in comparison to the C Mediterranean islands may reflect differences in the distance travelled over the sea and the Sahara (less distance in the case of birds crossing through the Balearics). These differences are known to influence noticeably the pattern of use and storage of fat reserves in other passerines (*cf.* Rubolini et al., 2002).

Stopover

The frequency of retraps is highest in N Morocco and the wet Balearics, and lowest in dry insular areas (table 2, fig. 5). Mean stopover lengths are rather short at all sites, ranging from *c.* 1.5 to 2.5 days. The few birds that stay in the dry Balearics and on Els Columbrets tend to be in poorer body condition than those that are not retrapped (nearly significantly so in the dry Balearics). This also indicates that this species tries to avoid these particular sites in favour of more forested stopover sites where they can feed. In fact, fuel deposition rates are significantly positive in Catalonia (retraps of more than one day) and the wet Balearics, but are negative on Els Columbrets and in the dry Balearics, although only significantly so in the former area when considering the full sample.

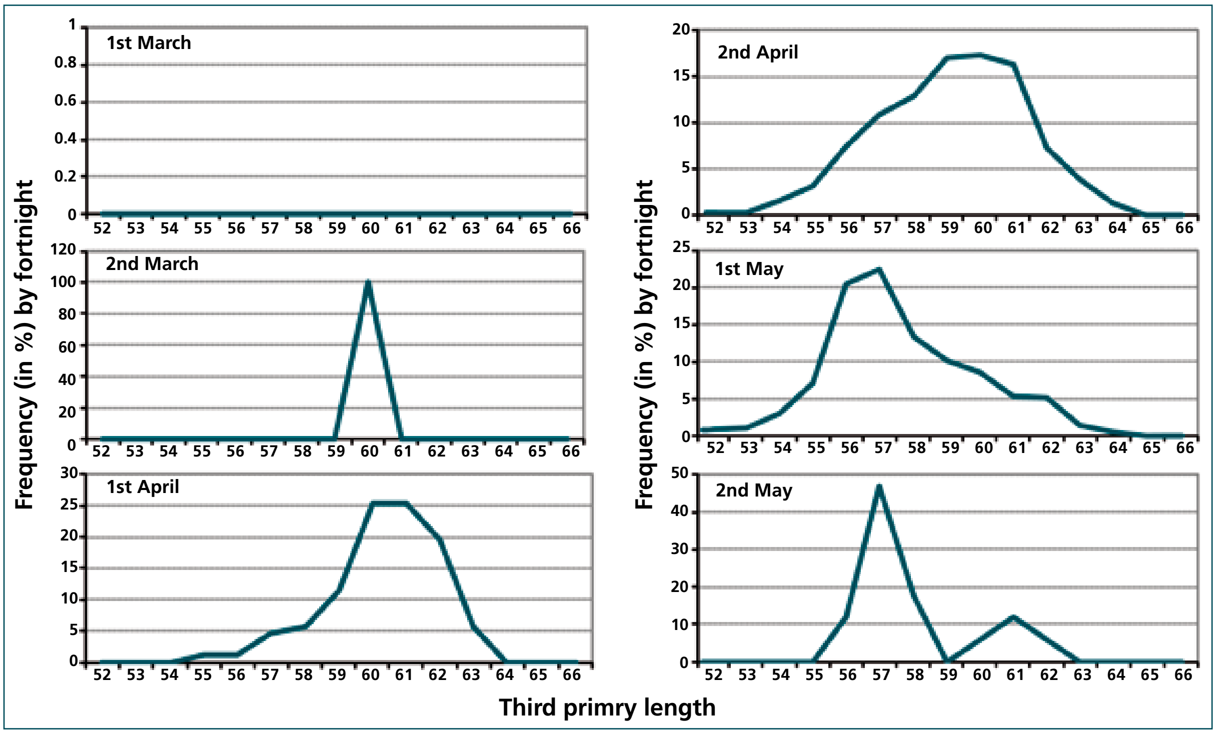


Figure a. Frequency distribution of the third primary length in fortnightly periods.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	179	76.3 ± 2.4 (70.5-82.0)	59.6 ± 2.1 (54.0-64.4)	9.2 ± 1.0 (6.9-11.7)	2.2 ± 1.3 (0-5)
Columbrets	123	76.8 ± 3.1 (70.4-82.0)	58.7 ± 2.6 (52.5-64.0)	8.1 ± 0.8 (5.1-10.7)	0.7 ± 0.9 (0-5)
Balearics (dry)	646	75.1 ± 2.7 (69.5-82.0)	58.4 ± 2.3 (51.5-64.5)	8.9 ± 1.1 (6.1-12.5)	1.9 ± 1.2 (0-5)
Balearics (wet)	46	76.4 ± 2.1 (72.0-81.0)	59.8 ± 1.9 (56.0-64.0)	9.5 ± 1.2 (7.5-12.7)	2.4 ± 1.2 (0-5)
Chafarinas	9		59.1 ± 1.8 (57.0-63.0)	9.3 ± 0.9 (7.8-10.3)	2.0 ± 1.0 (1-4)
N Morocco	47	76.0 ± 2.5 (71.5-81.0)	59.3 ± 2.1 (55.5-63.5)	9.7 ± 1.2 (6.5-12.1)	2.8 ± 1.4 (0-6)
S Morocco	1	78.0	60.5	7.5	4.0

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	0.13 ± 0.26 (19)	-0.25 ± 0.20 (7)	-0.12 ± 0.15 (38)	0.35 ± 0.24 (8)		-0.11 ± 0.27 (7)
Retraps >1 day	0.23 ± 0.17 (9)	-0.02 ± 0.16 (2)	-0.06 ± 0.16 (18)	0.27 ± 0.25 (3)		0.01 ± 0.37 (4)

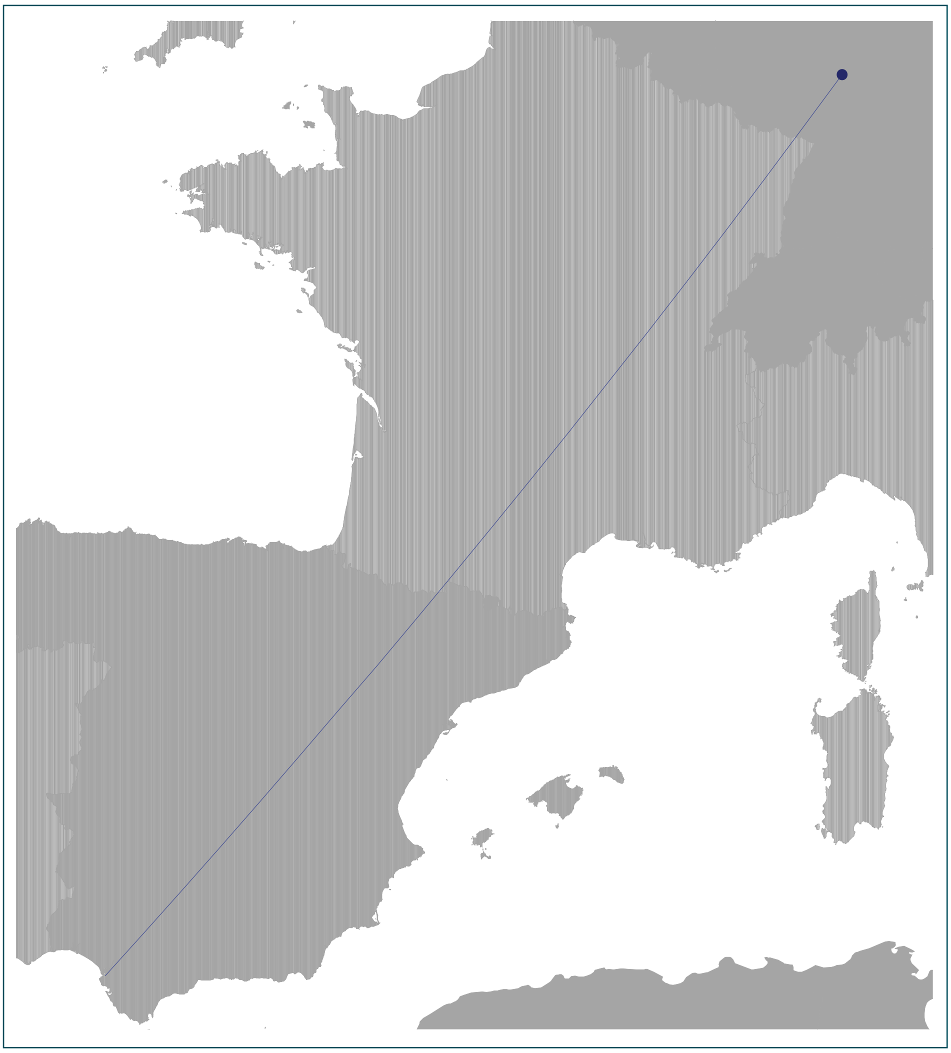


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

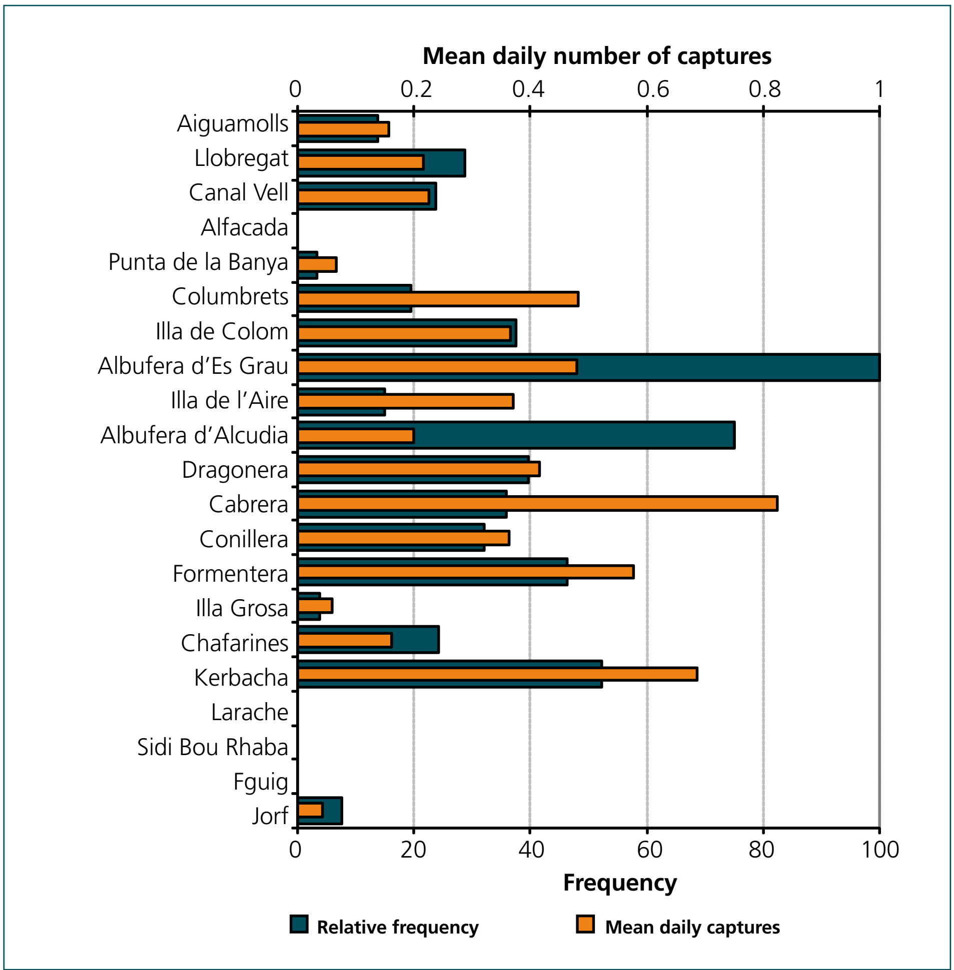


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

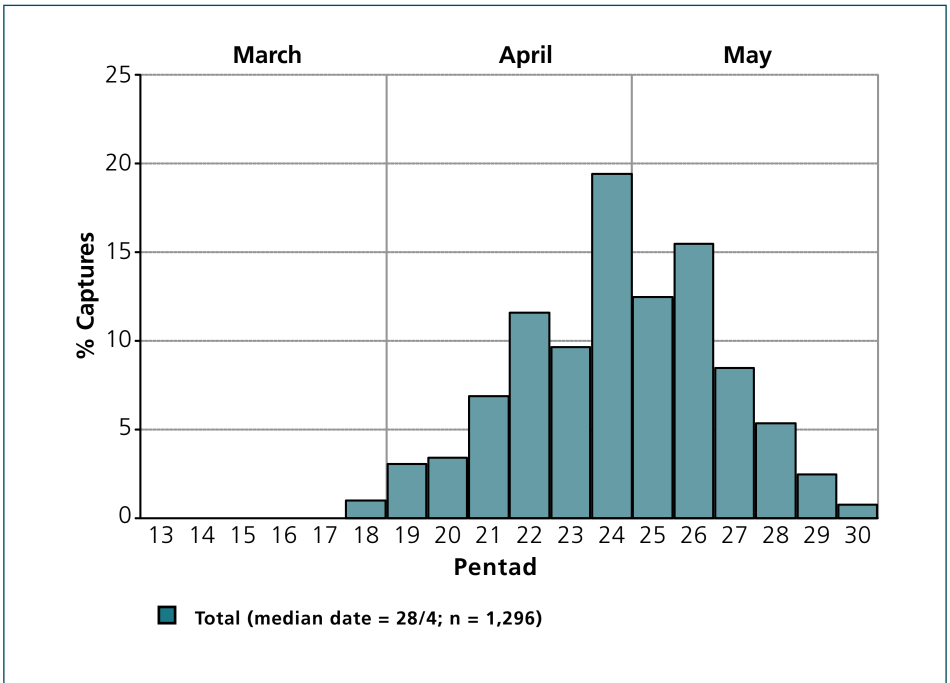


Figure 3. Frequency of captures during the study period.

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

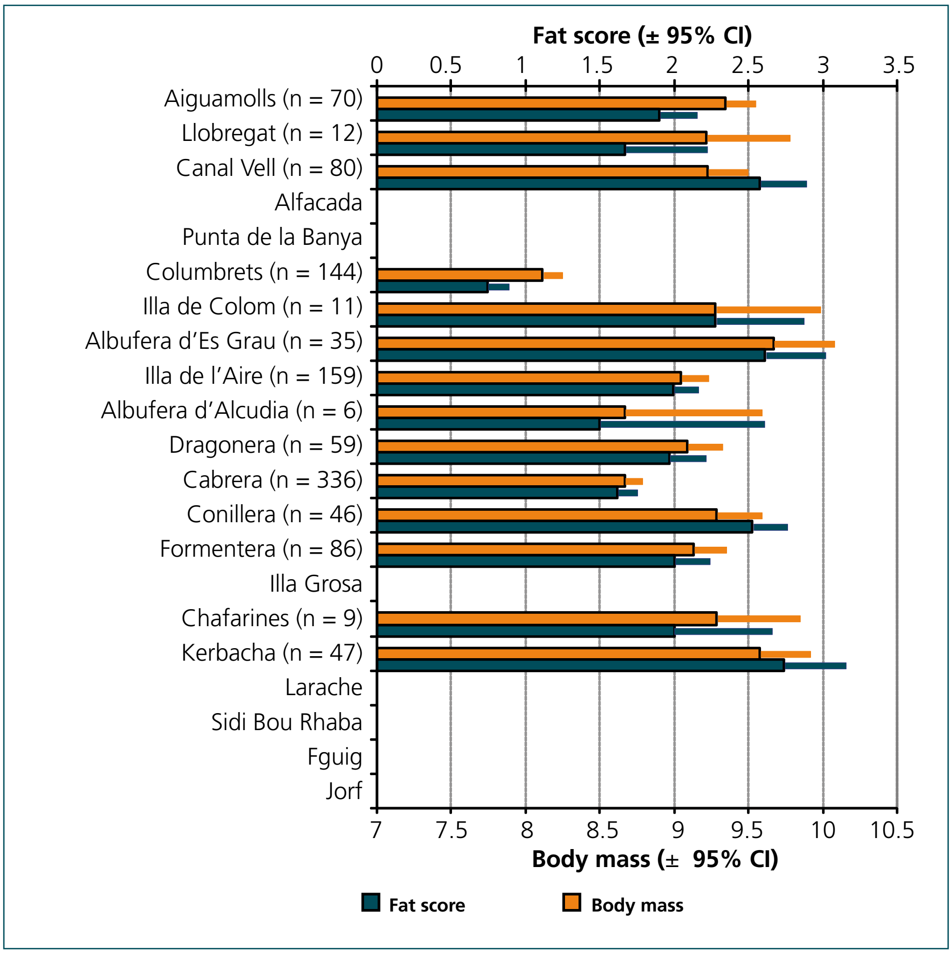
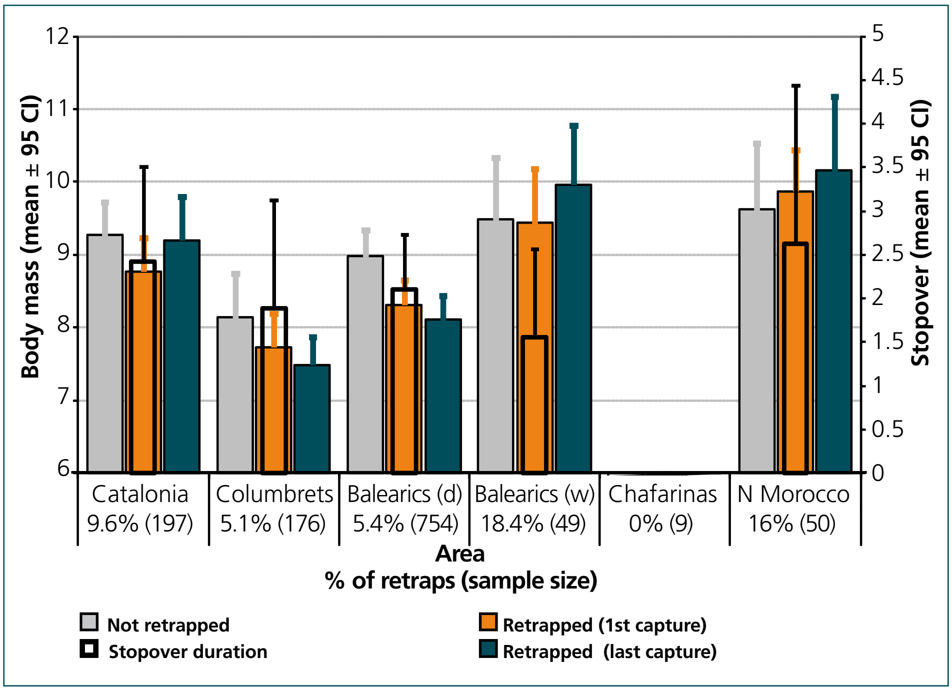


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



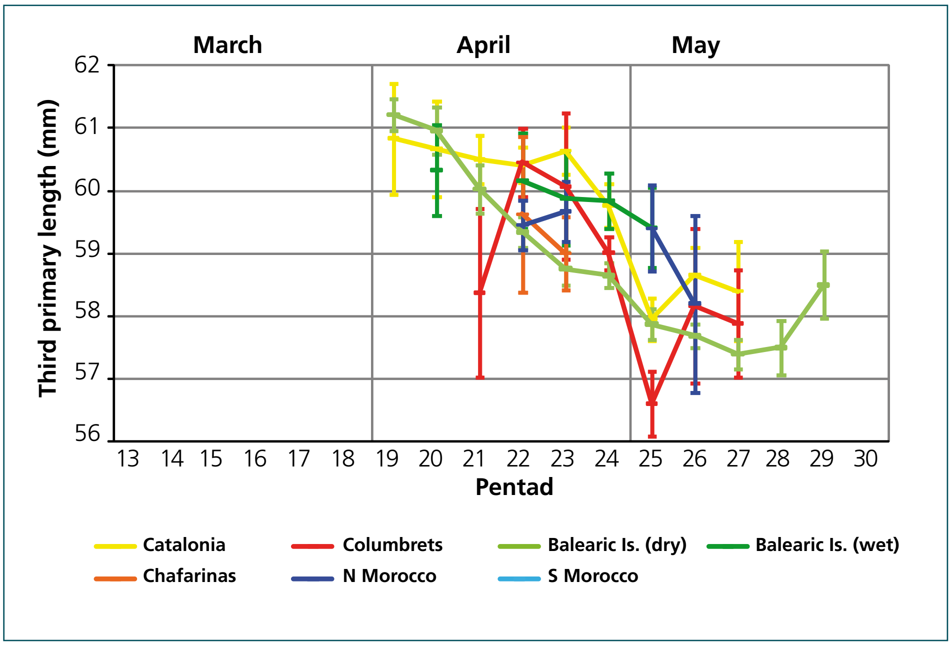


Figure 6. Temporal variation of third primary length according to area.

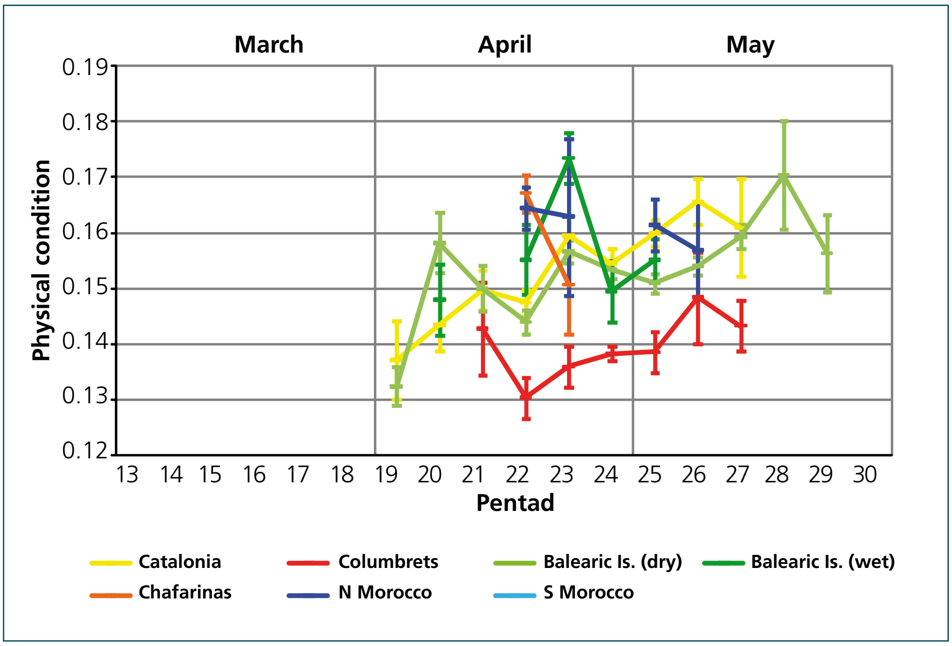


Figure 7. Temporal variation of physical condition according to area.

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

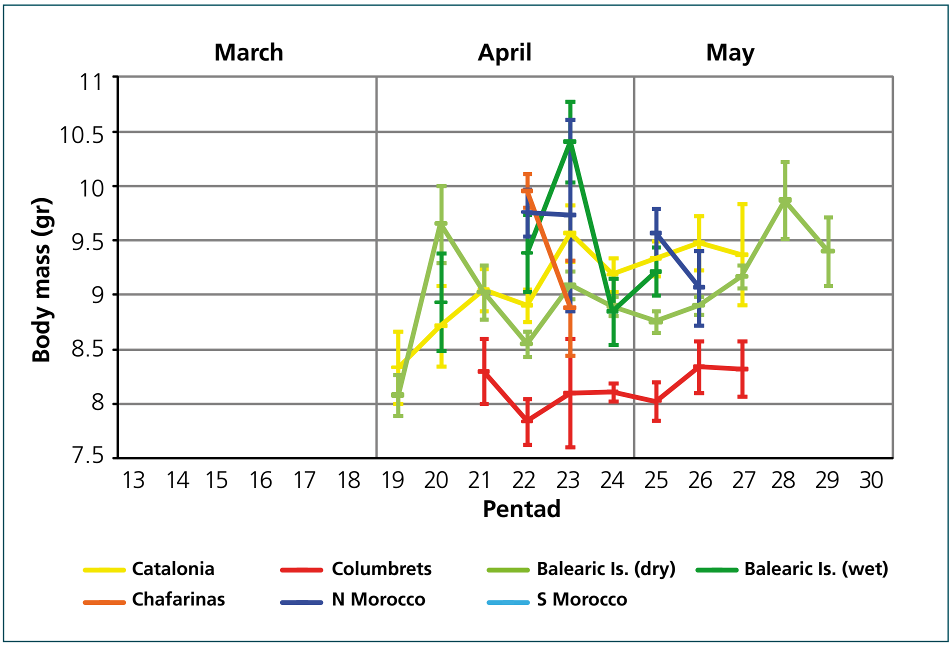
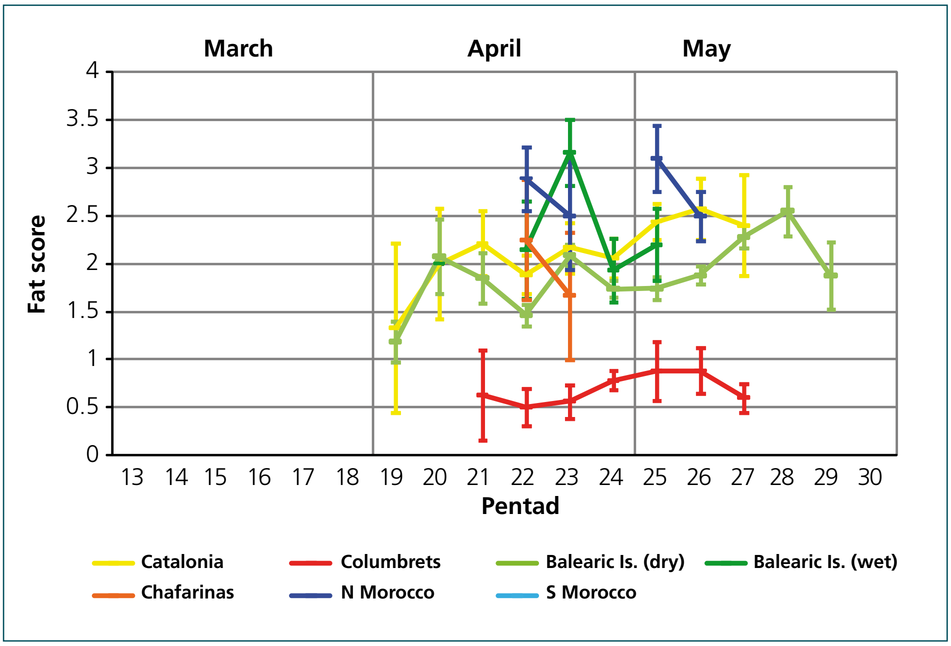


Figure 9. Temporal variation in fat score according to area.



Common Chiffchaff

Phylloscopus collybita

Carles Barriocanal & David Robson

Range

The Common Chiffchaff breeds in upper and lower middle latitudes of the W Palearctic, including most of Europe east as far as E Siberia (Cramp, 1992). It winters chiefly in SW Europe around the Mediterranean and in a huge area including the northern Afrotropics, Arabia and N India (Cramp, 1992). It does not breed on the Balearic Islands, in Morocco or at any of the ringing sites; however, it is a common wintering species in all areas except for the dry Balearics, Els Columbrets, L'Illa Grossa and Las Chafarinas, where migrants constitute the bulk of captures.

The recently split Iberian Chiffchaff *Phylloscopus ibericus* breeds in the Iberian Peninsula, S France and NW Africa, and winters primarily in tropical Africa (Svensson, 2001; Pérez-Tris et al., 2003; Catry et al., 2005). Records from Catalonia and the Balearics are very scarce but our sample from these areas undoubtedly includes a very few misidentified Iberian Chiffchaffs (since in former years this taxon was not systematically told apart). In Morocco, where Iberian Chiffchaffs are more common during migration (Gargallo et al., unpubl.), the number of birds wrongly identified as Common Chiffchaffs must be slightly higher.

Migratory route

Recoveries indicate that the Common Chiffchaff migrates on a broad front through the W Mediterranean towards its breeding grounds in C and N Europe, in the main heading SW-NE (fig 1; Zink, 1985). Unlike in autumn, the W Iberian Peninsula is largely devoid of birds in spring; while passage increases in coastal E Spain and the Balearics (present data; Cantos, 1992). An interesting deviation from the main migratory pattern comes in the form of a bird ringed in Barcelona in late March and recovered one month later in Sardinia (heading E-SE).

The geographical variation in the frequency of captures during the standard period gives little information in this case, since captures become much scarcer from mid-April onwards and data from Morocco may also include some Iberian Chiffchaffs (fig. 2). Taking into account the full study period, 24% of the birds were trapped in three continental wetland sites where the species is common both in winter and during migration: Els Aiguamolls, El Canal Vell and the Llobregat delta. The majority (66%), however, were ringed on three insular sites where this warbler is essentially migratory: L'Illa de l'Aire, Cabrera and Els Columbrets. It is clear from the high number of captures at these sites that these islands act as points of attraction for migrants needing to rest, and they are also proof that this species crosses the Mediterranean in good numbers. This is probably also the case for many birds from NW Africa, where the species is very common in winter (Cramp, 1992; Isenmann & Moali, 2000; Thévenot et al., 2003; Isenmann et al., 2005).

Phenology

Passage begins in February (outside the study period) followed by a peak in mid-March. Captures then decrease steadily through April, and a few individuals are still trapped well into May (fig. 3). The main pattern of passage is similar in the Balearics/Els Columbrets and Catalonia, although in N Morocco late passing birds are somewhat more frequent. Overall, passage through the study area is similar to that recorded in spring from Gibraltar (Finlayson, 1992), La Camargue (Blondel & Isenmann, 1981), the Tyrrhenian islands (Spina et al., 1993) and Israel (Morgan & Shirihai, 1997). No clear age-related differences in phenology are observed. The frequency distribution of third primary lengths, however, indicates a clear temporal segregation of sexes: males (distinctly larger; Cramp, 1992) pass during first half of March and females mostly from mid-March onwards (fig. a). This differential migration has also been observed in Eilat (Morgan & Shirihai, 1997) and the C Mediterranean (Spina et al., 1993). The early passage of male Chiffchaffs seems to be caused by their early departure from the wintering grounds and not only by a differential speed between sexes during migration (Catry et al., 2005). Interestingly, a new wave of larger birds (males) passes through the area from mid-April onwards (a pattern that may occur also in the C Mediterranean; *cf.* Spina et al., 1993). This new wave may reflect the passage of birds belonging to more north-eastern and late migrating populations (Cramp, 1992), perhaps wintering in tropical Africa. Recoveries do not reveal any pattern regarding the timing of passage and geographical origin because available data is very scarce late in the season.

Biometry and physical condition

Mean values for third primary lengths range from 43.8 (S Morocco) to 45.1 (Catalonia; table 1). In most areas averages are slightly higher than in the C Mediterranean (overall mean 43.8, n = 1,010; Spina et al., 1993), probably due to the inclusion of a higher proportion of males (as more early-season data is available). Mean values for wing lengths vary from 56.7 (dry Balearics) to 58.3 (Catalonia), within the range of the nominate race in W Europe (Cramp, 1992), but lower than in E Mediterranean, where birds from the larger north-eastern populations are common (Morgan & Shirihai, 1997). The third primary length shows a marked tendency to decrease during March, but then in early April the tendency inverts and is slightly upwards (fig. 6). This is a similar pattern to that previously found in the C Mediterranean (Spina et al., 1993) and reflects the differential migration of the sexes described above.

Mean fat scores range between 1.2 (Els Columbretes) and 2.8 (S Morocco). Fat is lowest on Els Columbrets, but otherwise differences between areas are not significant. Physical condition is also worst on Els Columbrets, but better in N Morocco than in Catalonia and the dry Balearics. Birds from the wet Balearics also have better physical condition than those from the dry Balearics, probably due to a higher proportion of wintering birds in the former area and its better suitability as a stopover site (it attracts a smaller proportion of migrants in poor condition and provides better feeding options for gaining mass). Fat shows a slight tendency to increase in March and decrease in May, reaching a peak in April (fig. 9); in the dry Balearics the overall temporal trend is significantly negative. Physical condition tends to increase slightly with time (fig. 7).

Mean body mass varies from 7.0 (Els Columbrets) to 7.6 (N Morocco; table 1). Seasonal variation differs between study areas, decreasing significantly in Catalonia and on Els Columbrets, but increasing in the wet Balearics; it shows no clear pattern in the dry Balearics and Morocco (fig. 8). Birds from N Morocco are similar to those from the wet Balearics, and both are significantly heavier than those from Catalonia; birds from Els Columbrets and the dry Balearics have the lowest average body mass. Average mass in N Morocco is somewhat higher than that reported by other authors in roughly the same area during March (mean 7.1, n = 41; Cramp, 1992) and similar to that reported in a very limited sample from N Tunisia (mean 7.6, n = 4; Waldenström et al., 2004). Mean values from S Morocco are higher than those reported from the nearby areas of Defilia (mean 6.3, n = 17; Ash, 1969) and Merzouga (mean 7.2, n = 78; Gargallo et al., unpubl.). The overall average body mass (mean 7.2; n = 140) is only slightly lower than in N Morocco. Although our data and that from Ash (1969) may include some Iberian Chiffchaffs, the body mass of both species is very similar in S Morocco (Gargallo et al., unpubl.). Body mass in Catalonia is only slightly higher than at Gibraltar (mean 7.0, n = 88; Finlayson, 1981) and similar or somewhat lower than that reported in Wales and the Netherlands further to the north (means 7.5 [n = 101] and 8.3 [n = 19], respectively; Cramp, 1992). Averages in the dry Balearics and on Els Columbrets are very similar to those reported from the C Mediterranean (mean 6.9, n = 1,010; Spina et al., 1993).

Overall, body mass shows very little geographical variation across NW Africa and SW Europe and average figures are mostly similar to those recorded during the breeding season (Cramp, 1992; ICO, 2010). Thus, the Chiffchaff seems to move through the area largely by means of short bouts of flight interspersed with brief stopovers (see also below). Fattening prior to cross the Mediterranean seems to be limited even in N Morocco.

Stopover

The proportion of birds remaining at ringing sites is low and the mean minimum stopover length is only 3-5 days in most areas (table 2, fig. 5). There are no retraps from N Morocco in spite of the relatively large sample size. Birds are unable to gain mass in any area and fuel deposition rates are only marginally significant in the dry Balearics (negative) and the wet Balearics (positive) when considering retraps of more than one day. Stopover length is significantly longer in Catalonia and the wet Balearics than in the dry Balearics, moreover birds staying in the first two of these areas do not have significantly lower initial body mass than those not trapped again (as is the case in the dry Balearics). Birds from Els Columbrets seem to act in a similar manner to the dry Balearics; however, retraps are also too scarce at this site to be conclusive. The presence of wintering birds early in the season may explain part of these site-related differences, since they are common in Catalonia and the wet Balearics and all but absent from the other areas. Using only data from the standard period (16 April to15 May), when the vast majority of captures undoubtedly involve migrants, the pattern of fuel deposition –but not stopover length– shows similar but not significant differences (albeit with a much smaller sample size: 63 retraps in the dry Balearics *vs.* 19 in Catalonia). Data, however, show again that at isolated sites with unsuitable habitats birds that stay tend to be in poorer initial body condition, indicating that these sites do not offer good opportunities for refuelling.

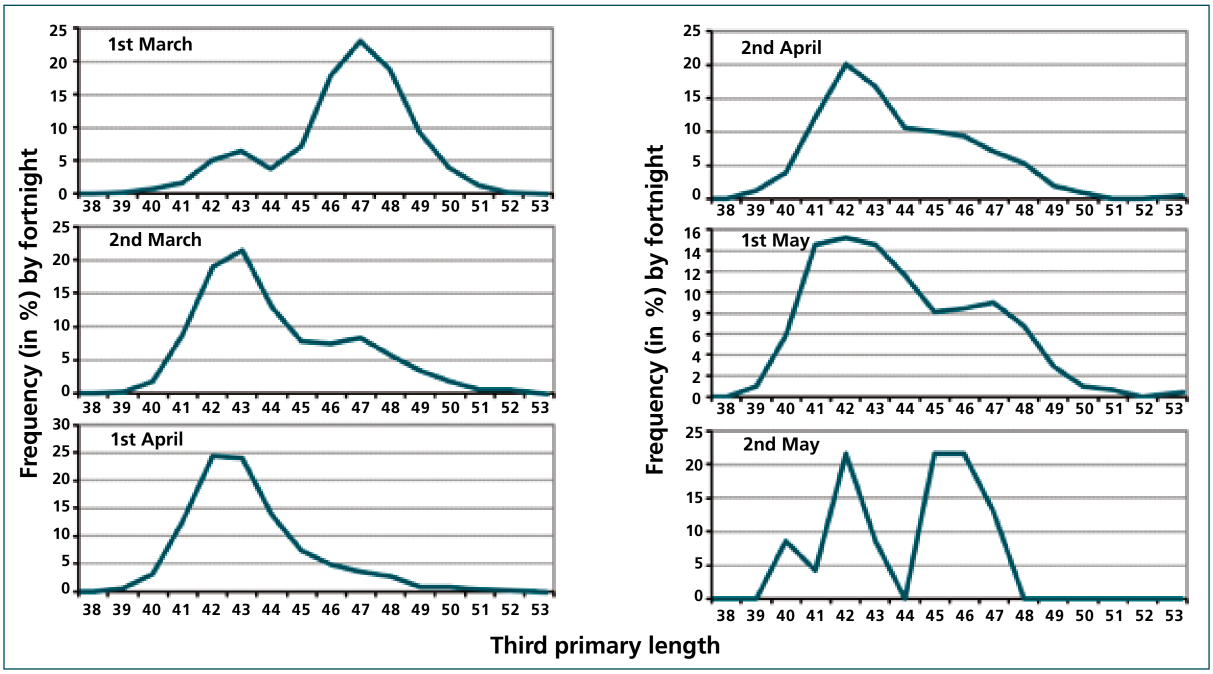


Figure a. Frequency distribution of the third primary length in fortnightly periods.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	2,187	58.3 ± 3.1 (52.0-68.0)	45.1 ± 2.6 (39.0-54.0)	7.5 ± 0.8 (4.8-12.5)	2.7 ± 1.2 (0-6)
Columbrets	661	58.2 ± 3.5 (50.0-69.5)	44.7 ± 2.9 (39.0-54.5)	7.0 ± 0.8 (5.0-9.9)	1.2 ± 1.1 (0-6)
Balearics (dry)	3,157	56.7 ± 2.9 (50.0-69.0)	43.8 ± 2.4 (39.0-55.0)	7.1 ± 0.8 (4.6-13.6)	2.5 ± 1.2 (0-8)
Balearics (wet)	139	57.8 ± 3.1 (51.0-65.5)	44.6 ± 2.4 (39.0-51.0)	7.5 ± 0.8 (5.3-9.8)	2.3 ± 1.1 (1-5)
Chafarinas	6		44.8 ± 1.8 (42.0-47.0)	7.3 ± 1.0 (6.3-9.1)	1.5 ± 1.9 (0-5)
N Morocco	82	57.7 ± 3.0 (51.0-64.0)	43.9 ± 2.5 (39.0-51.0)	7.6 ± 1.0 (5.0-10.3)	2.6 ± 1.4 (0-6)
S Morocco	43	57.9 ± 2.8 (54.0-64.0)	43.8 ± 2.2 (40.0-48.0)	7.6 ± 1.2 (5.0-10.3)	2.8 ± 1.5 (1-7)

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	-0.06 ± 0.04 (299)	-0.08 ± 0.13 (30)	-0.12 ± 0.05 (243)	0.09 ± 0.11 (20)		
Retraps >1 day	-0.01 ± 0.03 (214)	-0.04 ± 0.10 (18)	-0.05 ± 0.04 (130)	0.04 ± 0.04 (18)		

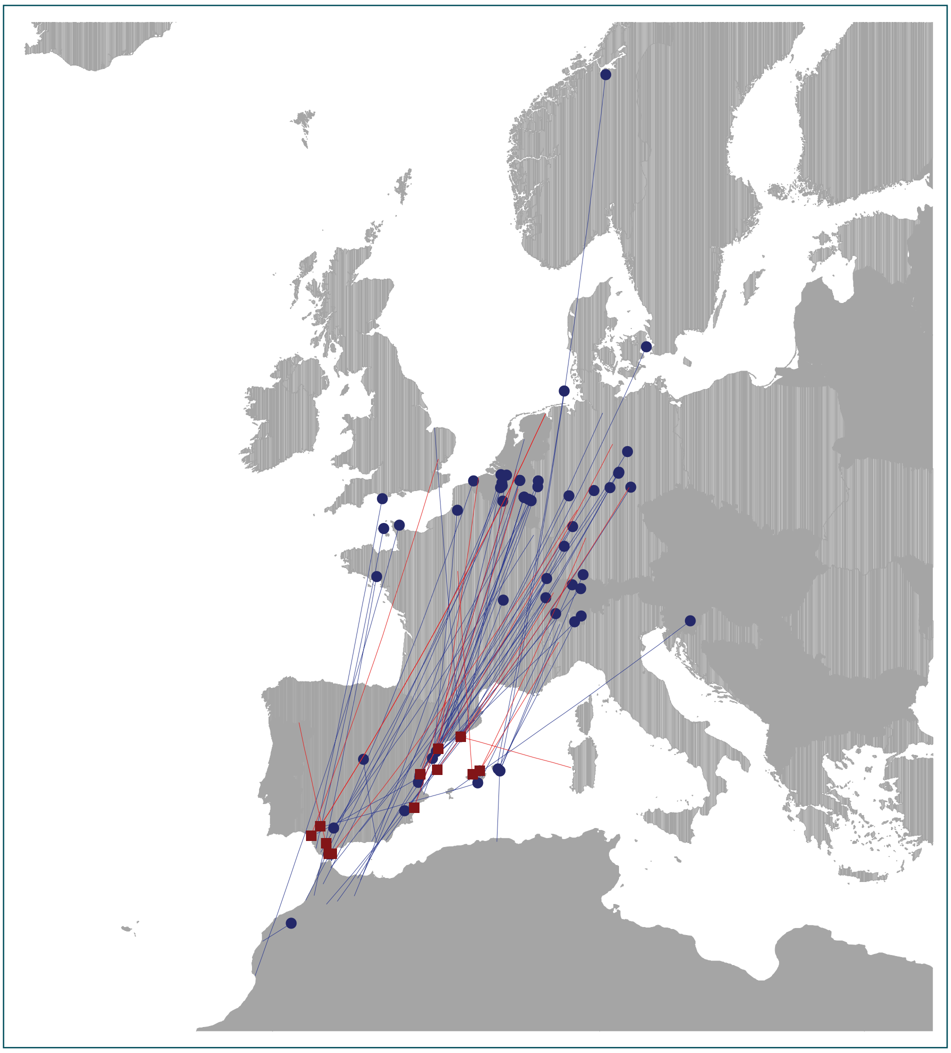


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

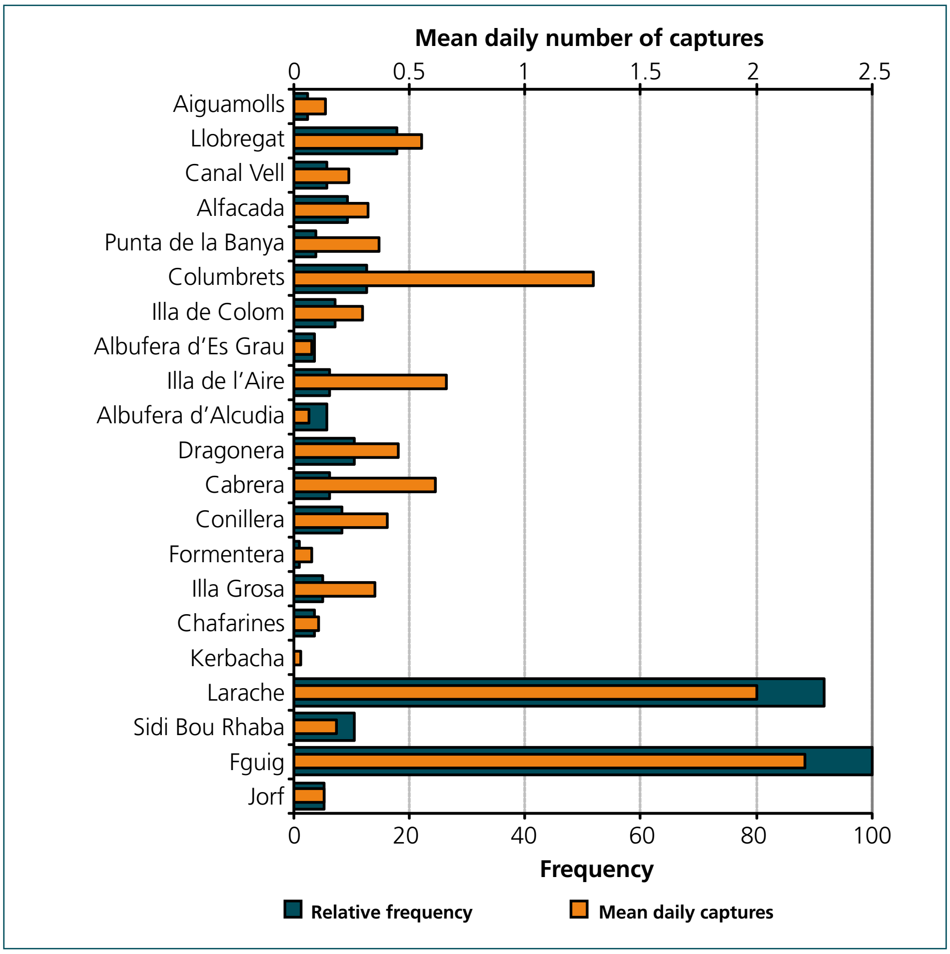


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

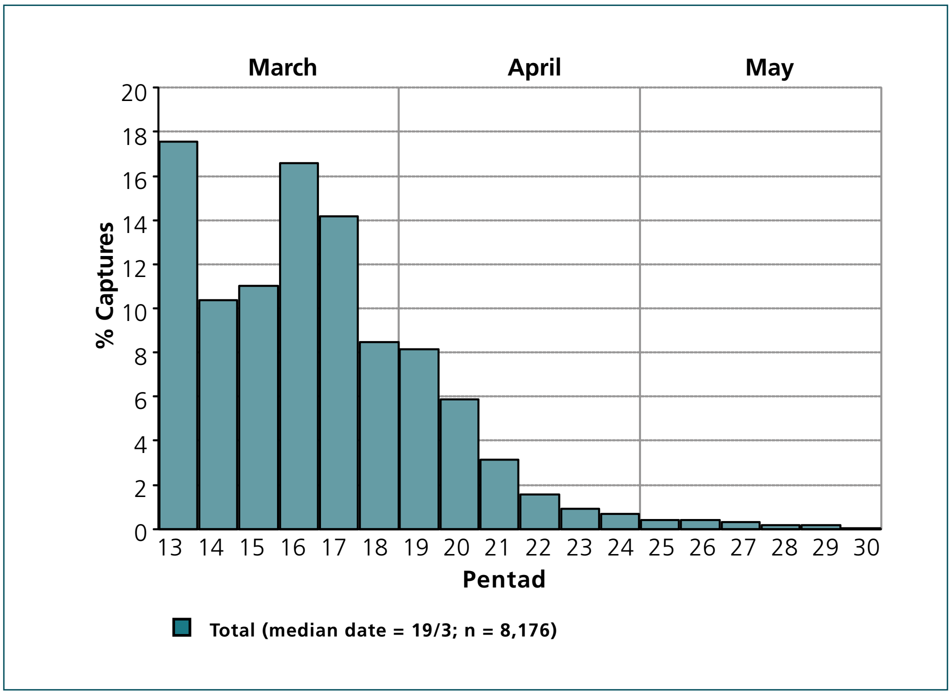


Figure 3. Frequency of captures during the study period.

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

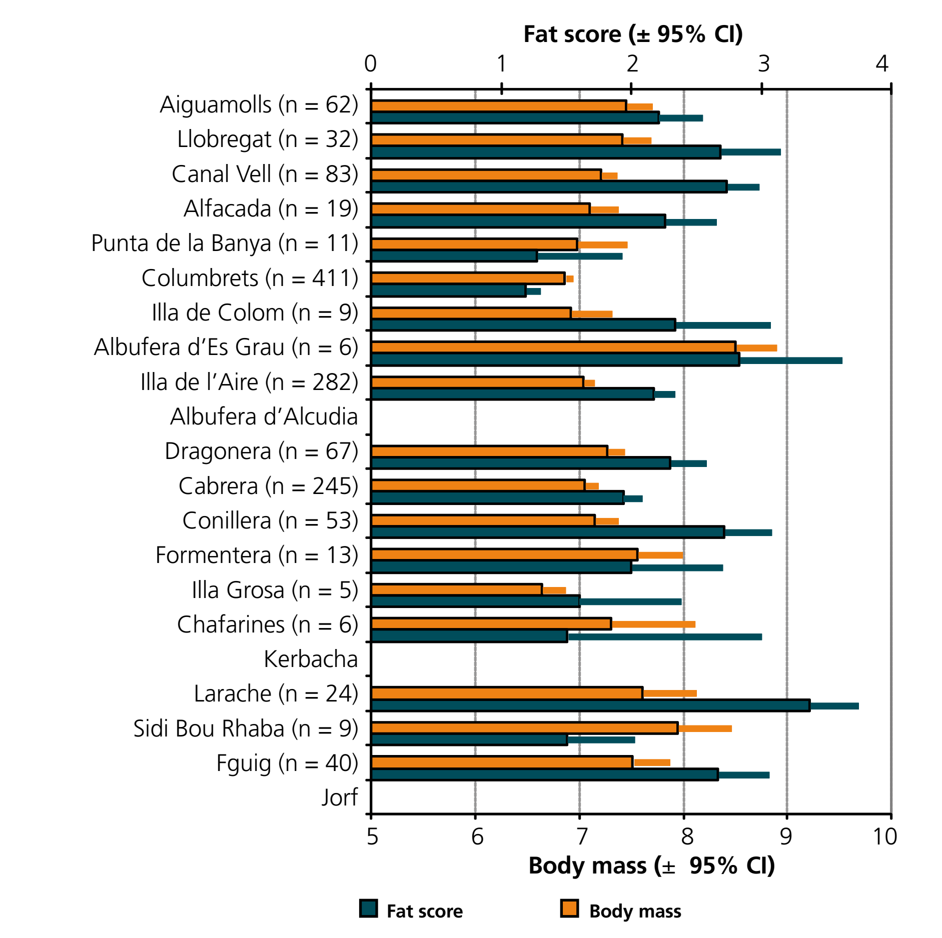
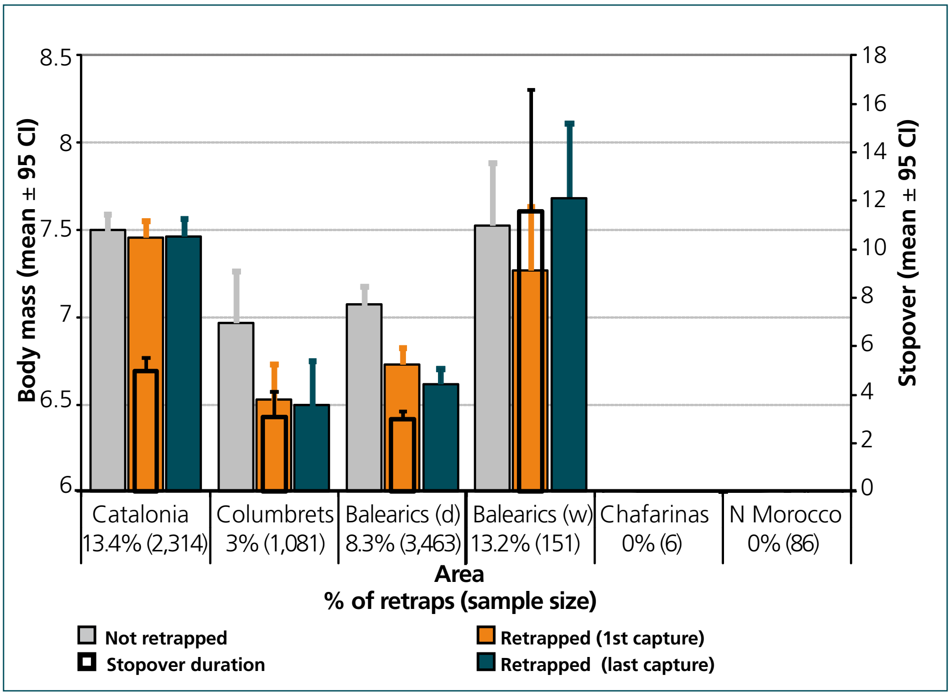


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



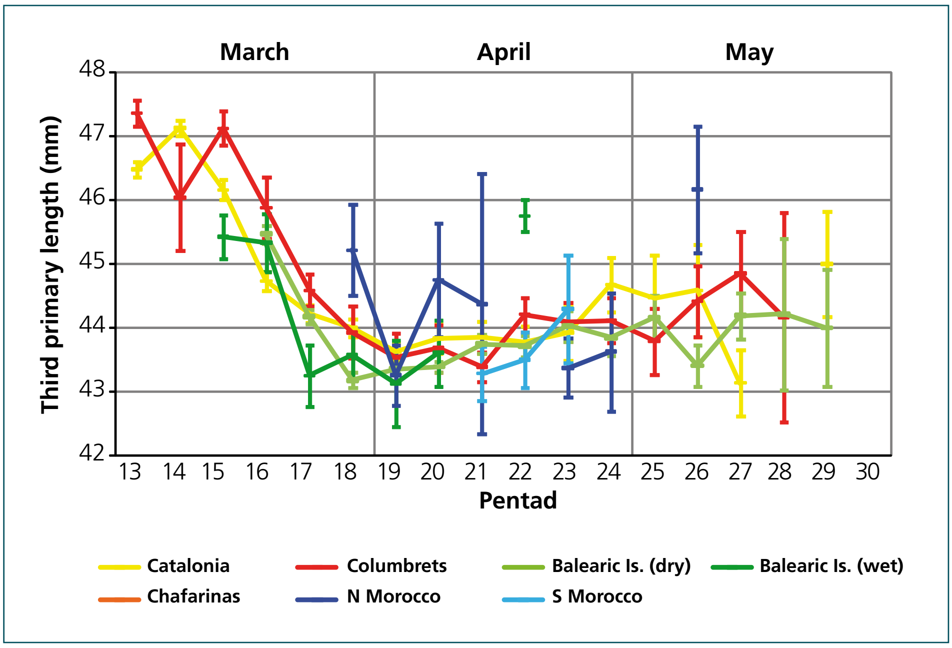


Figure 6. Temporal variation of third primary length according to area.

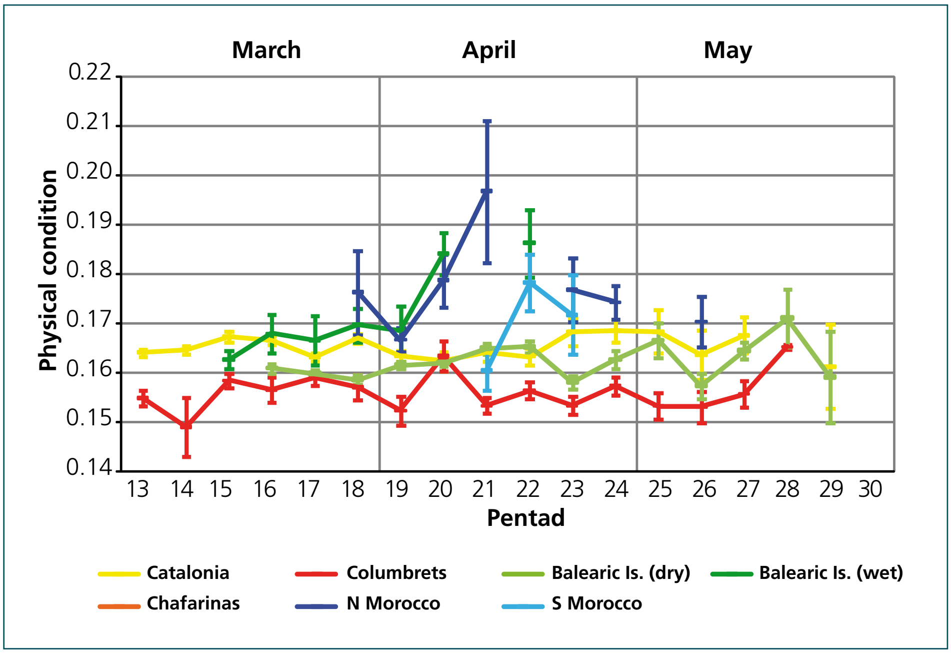


Figure 7. Temporal variation of physical condition according to area.

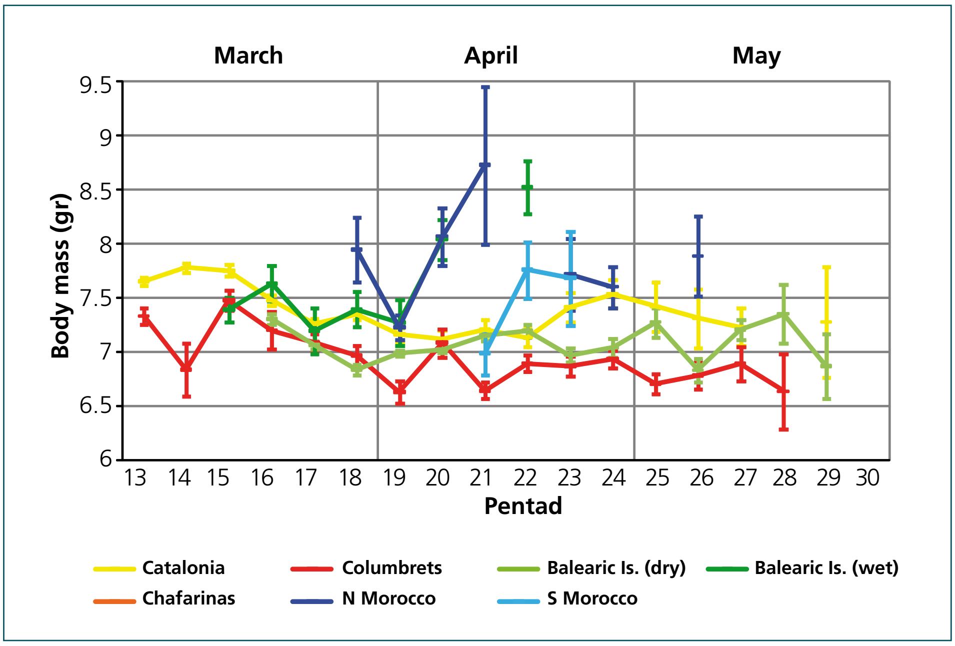


Figure 8. Temporal variation in body mass according to area.

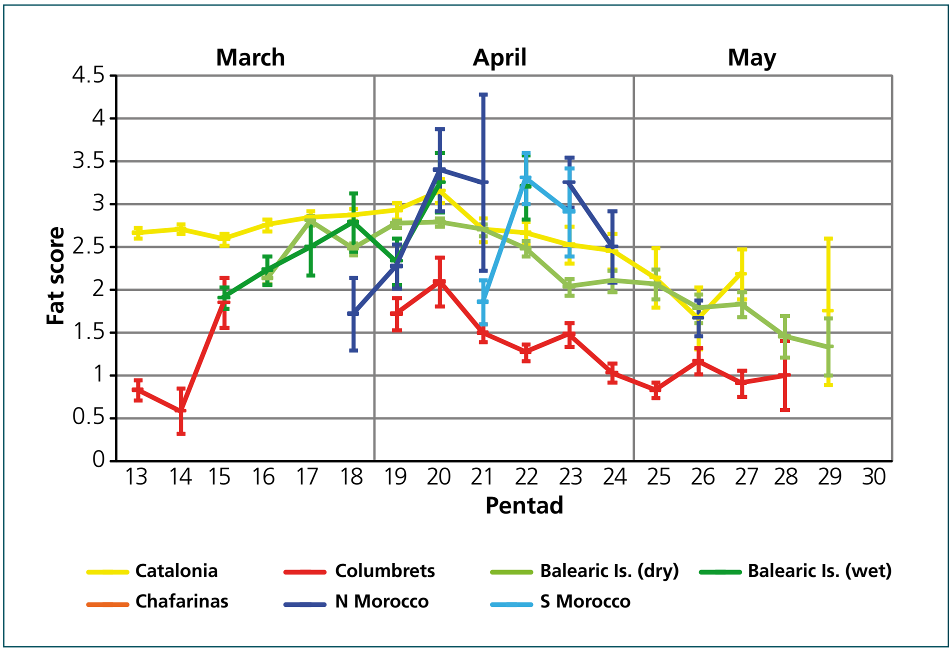


Figure 9. Temporal variation in fat score according to area.

Willow Warbler
Phylloscopus trochilus

Carles Barriocanal & David Robson

Range

The Willow Warbler is a polytypic species that breeds throughout C and N Europe, and eastwards to NE Siberia (Cramp, 1992). It is a long-distance migrant, wintering in most of sub-Saharan Africa as far south as S Africa (Hedenström & Petterson, 1987; Cramp, 1992). It does not breed in the study area.

Migratory route

Recoveries indicate that most birds cross NE Spain and the Balearics heading N-NE towards Central Europe and SW Scandinavia; however, birds using a more due N or even NW direction (towards UK) are not uncommon (fig. 1). In Morocco and S Spain birds show a more pronounced NE direction that avoids the most western parts of the Iberian Peninsula. In fact, as observed in many other species, spring migration through Spain takes place largely along the east coast and the Balearic Islands, but in autumn follows a much more westerly direction (Cantos, 1992). This pattern is exemplified by eight recoveries of birds trapped in the Balearics/Els Columbrets during spring and in continental Spain and Portugal, much further west, in autumn (360 to 1,140 km apart). At least some birds make clear W-E movements, apparently across the sea, as exemplified by one individual ringed near Barcelona and trapped only three days later in N Sardinia. Some birds seem to cross the Mediterranean at different places every year: for example, eight birds were trapped in different springs at sites in Spain and Italy 340 to 1,450 km apart. Likewise, two birds were trapped in the Balearics one spring and then due west in continental Spain (398 and 927 km away) in another spring.

The abundance of captures in the Balearics and on Els Columbrets suggests that this species crosses the Mediterranean along a broad front and has no qualms about flying over large stretches of sea (fig. 2). However, maximum frequencies and raw number of captures occur largely on very small islands or even on quasi-islands close to the continent (*e.g.* L'Illa Grossa and La Punta de la Banya), independently of the availability of adequate habitat. These findings suggest that these sites act as attraction points for many migrants needing to rest whilst crossing the sea.

Phenology

The first birds pass through the W Mediterranean during mid-March, giving way after a peak in April to a steady decrease in May (fig. 3). The median date of passage is somewhat earlier than that observed on Capri (29 April; Pattersson et al., 1990) and on two other Tyrrhenian islands (Spina et al., 1993). This slight difference probably reflects the greater frequency of birds of more northerly and easterly origin passing through Italy (*cf.* Spina & Volponi, 2009). Recoveries show that the further north birds are ringed/recovered, the later they pass through the study area, indicating that the northern populations delay their migration (the opposite is found during autumn migration in Spain; Cantos, 1992). This delayed migration and arrival of more northern populations (*cf.* Cramp, 1992) could thus be a response to a parallel delay in the spring availability of food in northern Europe (Schüz, 1971). Overall, passage is very similar in all three main areas: Catalonia, N Morocco and the Balearics/Els Columbrets, although on the islands birds tend to pass *c.* 5 days later than in Catalonia (as observed by Barriocanal & Robson, 2007).

The frequency distribution of third primary lengths indicates that males (distinctly larger; Cramp, 1992) migrate during March and April and females mostly from mid-April onwards (fig. a). This differential migration of sexes accounts, at least in part, for the slight bimodality of the phenological curve (fig. 3). As described in other species, males are in more of a hurry to fly ahead of females in order to increase their chances of obtaining a good territory or mate (Heddenström & Petterson, 1986).

Biometry and physical condition

Mean values for third primary lengths range from 49.4 in Las Chafarinas to 52.9 in the wet Balearics (table 1), similar values to those reported in the C Mediterranean (overall mean 50.9, n = 20,381; Messineo et al., 2001). Mean values for wing lengths vary from 66.1 on Els Columbrets to 68.4 in the wet Balearics, likewise similar to those reported in the C Mediterranean (mean 66.9, n = 12,972; Messineo et al., 2001), N Tunisia (mean 66.7, n = 132; Waldenström et al., 2004) and S Israel (mean 67.9, n = 312; Morgan & Shirihai, 1997), revealing the homogeneity in size of populations crossing the Mediterranean. The third primary decreases in size with time (fig. 6), a similar pattern to that found in the C Mediterranean (Spina et al., 1993) and a reflection of the differential migration of sexes described above.

The mean fat score is similar to that recorded in the C Mediterranean (Messineo et al., 2001), although birds captured on Las Chafarinas and Els Columbrets have fairly low values. Fat increases with the season in Catalonia, the wet Balearics and N Morocco, but decreases on Las Chafarinas and Els Columbrets (fig. 9). Physical condition also decreases significantly on Els Columbrets and Las Chafarinas and also in the dry Balearics, while the trend is positive in S Morocco and slightly so in Catalonia (fig. 7). Mean body mass varies from 7.4 on Las Chafarinas to 9.4 in S Morocco, decreasing markedly during the season (table 1, fig. 8). Body mass is distinctly lower on Las Chafarinas and Els Columbrets than in N Morocco, Catalonia and the dry Balearics, while the wet Balearics has the highest average outside Morocco. Average fat has a similar pattern, although the mean is slightly higher in Catalonia than in N Morocco and the dry Balearics; differences between the sites in the Balearics are inexistent. Physical condition is significantly better in N Morocco and the wet Balearics than in the dry Balearics and Catalonia, while birds on Els Columbrets and Las Chafarinas have the lowest values.

Body mass in Catalonia similar to that reported in S Britain and C Europe (means in the range 8.8-9.1; Cramp, 1992), but somewhat higher than in S Iberia (mean at Gibraltar 8.0, n = 82; Finlayson, 1981). The mean body mass in the dry Balearics and on Els Columbrets is similar to that reported in the C Mediterranean (mean 8.3, n = 20,485; Messineo et al., 2001). Smith (1979) gives similar figures to those found by this study in N Morocco for Kaifiene, also in north of this country (mean 8.9, n = 27). Surprisingly, however, mean body mass in S Morocco is generally greater than that reported in much larger datasets from the same area, with means of 7.9 at Defilia (n = 191; Ash, 1969) and 8.0 in Merzouga (n = 350; Gargallo et al., unpubl.), and also greater than birds from the W Algerian Sahara (mean 7.7, n = 187; Cramp, 1992) and the northern edge of the desert in Israel (mean 7.5, n = 312; Morgan & Shirihai, 1997). These high figures most probably reflect very unusual conditions that require further study.

Our results indicate that birds achieve some gain in body mass during their stay in N Morocco, birds being *c.* 8-17% heavier than in the south of the country (calculated using the whole dataset available for S Morocco and excluding our unusual sample). However, mean body mass in Catalonia and further north in W Europe is similar to that given for N Morocco, suggesting that once birds leave N Africa, migration through continental Europe takes places in short bouts that do not require long stopovers or marked new gains in mass (as shown below). On the other hand, the fact that mean body mass in birds trapped in the dry Balearics (mostly recently arrived birds) is similar to that of N Morocco indicates that the birds that migrate through the islands (a minimum *c.* 250 km non-stop flight) have to be heavier than average N Moroccan birds when they depart from N Africa.

It is interesting to note that birds trapped in Las Chafarinas have a significantly shorter third primary, lower body mass and fat, and poorer body condition than those from continental N Morocco. This is particularly relevant taking into account that these differences are significant when considering only data from Kerbacha, located only a few km to the south of Las Chafarinas (fig. 4). Mean values on Las Chafarinas are similarly low in all available years (2000 and 2001) and differences in fat, body mass and condition remain similarly significant when comparing data from Las Chafarinas and Sidi Bou Rhaba from 2000. A similar pattern is observed in the Balearics: birds from the dry Balearics also have significantly shorter wings, lower body mass and poorer body condition than those trapped in more suitable habitats on the larger islands (wet Balearics). Overall, these results clearly suggest that Las Chafarinas and the dry Balearics attract a higher proportion of birds in poor body condition. In the case of Las Chafarinas, this is apparently due to the fact that birds are often forced to change or reverse flight direction due to unfavourable meteorological circumstances encountered during sea crossing (this study site is a mere 4 km north of the Moroccan coast). The fact that birds trapped in these areas also have shorter wings suggests that smaller birds may be more prone to suffer from such unfavourable circumstances (particularly strong head winds; *cf.* Saino et al., 2010), or that females and younger individuals (with shorter wings) may take fewer risks (having less of a need to migrate faster and arrive earlier) and thus be more inclined to stop at suboptimal habitats or reverse migration when facing problems. On the other hand, birds stopping at wetlands may gain mass faster and include a greater proportion of larger dominant birds (*i.e.* males; the species is known to hold territories during migration and is prone to exhibit intraspecific aggressions; Cramp, 1992; Salewski et al., 2007) or of birds that have already been on land for a few days (either at the site itself or other surrounding areas; see below), which may also contribute to their overall better average body condition and the larger size of birds trapped at these sites.

On Els Columbrets, the most isolated islands and the most distant from N Africa, birds have the lowest mean levels of fat and body mass, and the poorest condition of all the W Mediterranean islands, in a clear signal of the progressive depletion of the energetic reserves during sea crossing.

Stopover

Overall birds do not tend to stay long at the study sites and have rather low mean stopover lengths (2-3 days; table 2, fig. 5). The highest percentage of recaptures occurs in N Morocco, Catalonia and the wet Balearics. Stopover length is higher in N Morocco, although differences are not statistically significant. Birds remaining in N Morocco, Catalonia and the wet Balearics tend to have higher body mass at departure than at first capture, but not significantly so. Fuel deposition rates, however, are significantly positive in Catalonia and, above all, in N Morocco (when excluding one-day retraps). On the other hand, in the dry Balearics birds lose some mass during the course of their stays and show significantly negative fuel deposition rates. Moreover, in the dry Balearics and on Els Columbrets retrapped birds have lower initial body mass than those not trapped again. These results suggest that these sites do not offer good opportunities for refuelling and that many birds unable to continue migration remain –unsuccessfully– in these areas. In Catalonia, the wet Balearics and, above all, N Morocco birds are not necessarily forced to stay due to poor body condition and can gain some mass or, at least, maintain their energetic reserves before restarting their migrations. The relevance of N Morocco as a stopover site for Willow Warblers is further supported by the relative high frequency of spring recoveries in the area (Zwarts et al., 2009). On Las Chafarinas, birds show significant positive fuel deposition rates, although the sample is too small to be conclusive.

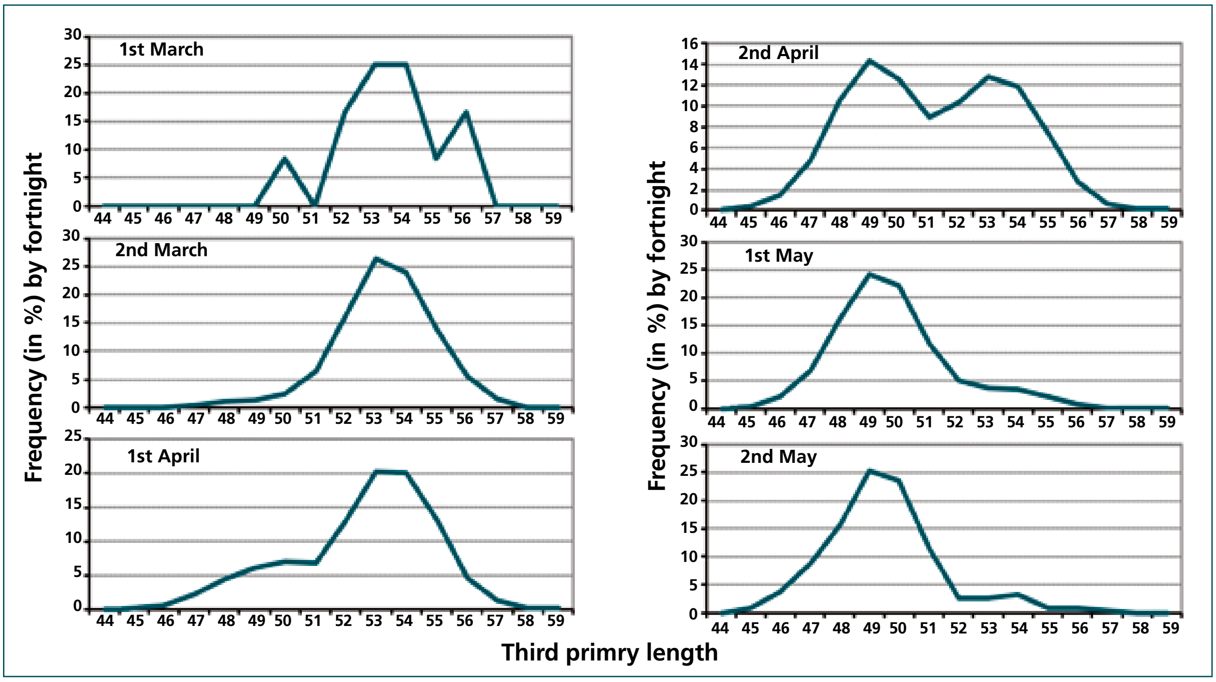


Figure a. Frequency distribution of the third primary length in fortnightly periods.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	8,666	67.1 ± 3.0 (57.0-76.0)	51.9 ± 2.6 (41.0-59.5)	8.7 ± 0.9 (5.3-13.5)	3.1 ± 1.2 (0-7)
Columbrets	6,728	66.1 ± 3.1 (57.0-76.0)	50.7 ± 2.6 (41.0-59.5)	8.2 ± 1.1 (5.4-14.4)	1.8 ± 1.3 (0-8)
Balearics (dry)	26,564	66.2 ± 3.1 (57.0-76.0)	51.1 ± 2.6 (41.0-59.5)	8.6 ± 1.1 (5.0-14.5)	3.0 ± 1.3 (0-8)
Balearics (wet)	363	68.4 ± 2.7 (60.0-75.0)	52.9 ± 2.3 (46.0-59.5)	9.0 ± 1.0 (6.4-11.8)	2.8 ± 1.1 (0-6)
Chafarinas	264		49.4 ± 2.0 (44.0-55.5)	7.4 ± 0.9 (5.9-11.1)	1.6 ± 1.1 (0-5)
N Morocco	526	66.2 ± 3.3 (59.0-75.0)	50.7 ± 2.6 (43.0-59.5)	8.8 ± 1.2 (6.1-14.5)	2.7 ± 1.4 (0-7)
S Morocco	91	67.6 ± 3.0 (62.0-72.0)	51.5 ± 2.5 (47.0-59.0)	9.4 ± 1.3 (7.0-14.5)	3.2 ± 1.3 (1-7)

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	-0.05 ± 0.05 (368)	-0.19 ± 0.20 (59)	-0.23 ± 0.05 (493)	0.20 ± 0.23 (19)	0.38 ± 0.12 (7)	0.03 ± 0.14 (48)
Retraps >1 day	0.08 ± 0.04 (204)	-0.17 ± 0.22 (20)	-0.08 ± 0.04 (229)	0.06 ± 0.21 (9)	0.35 ± 0.13 (4)	0.20 ± 0.11 (34)

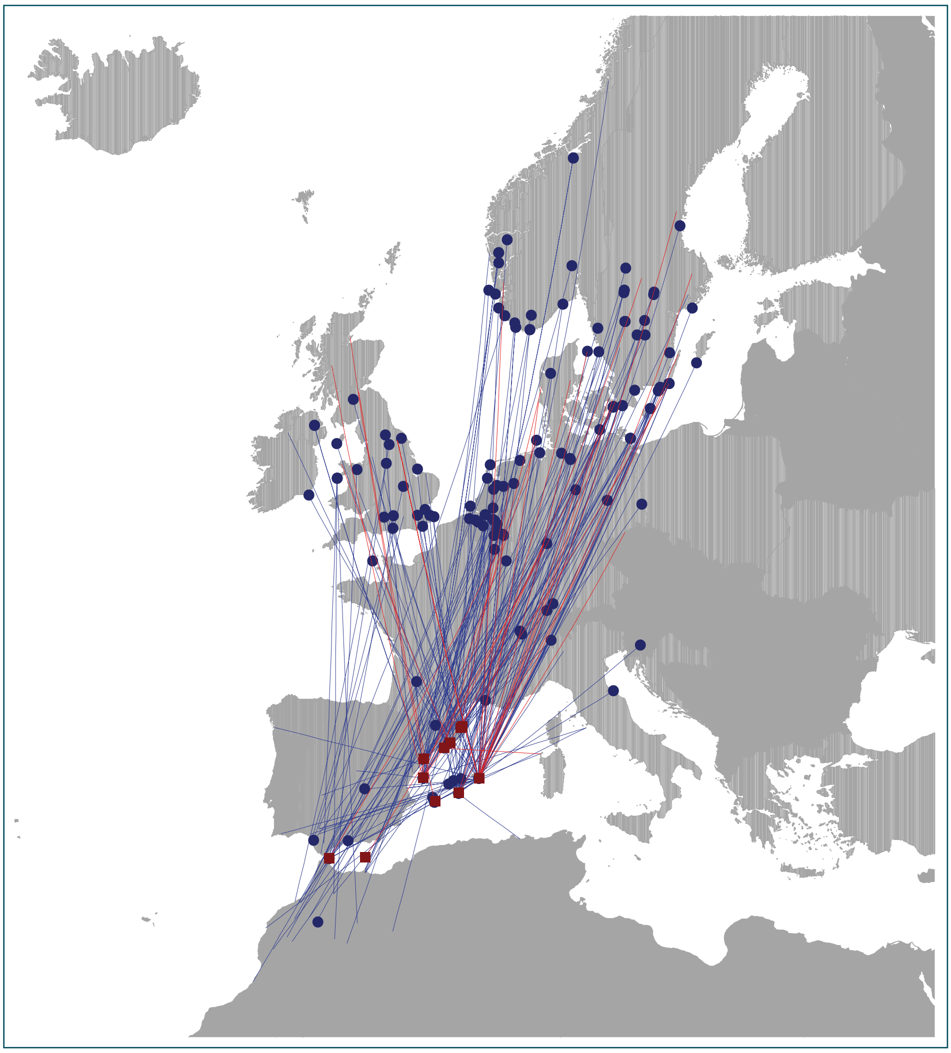


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

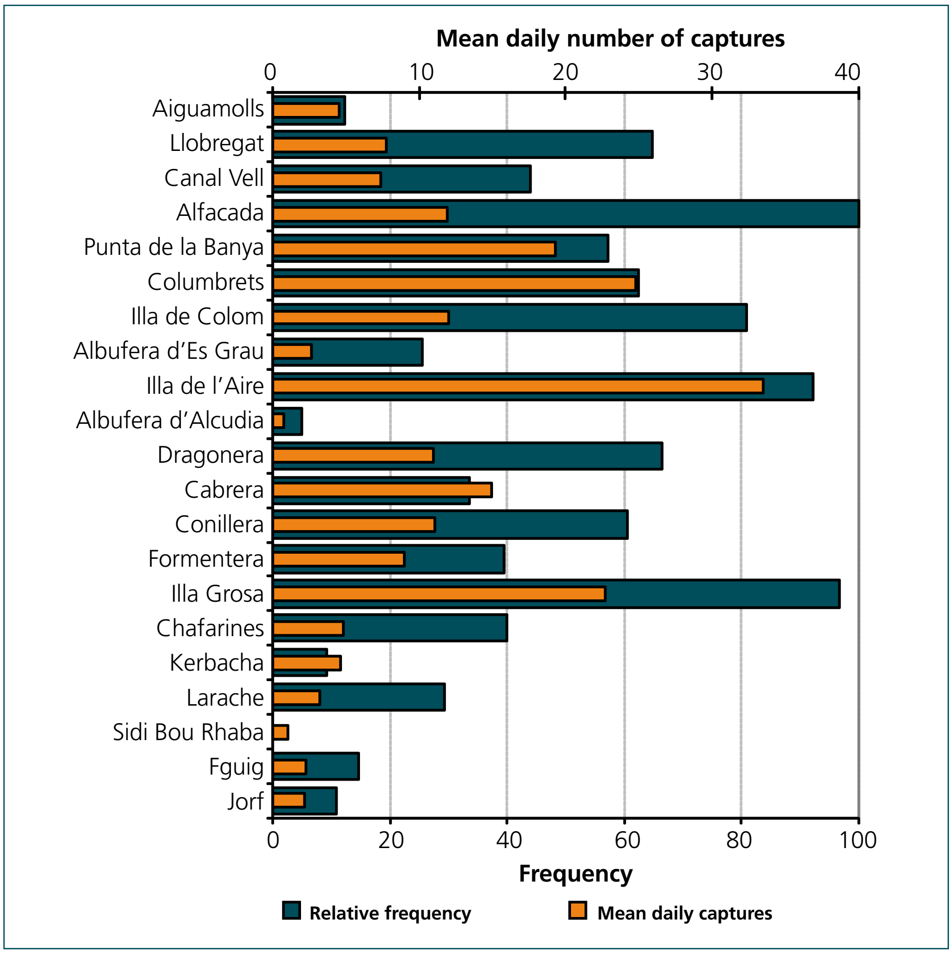


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

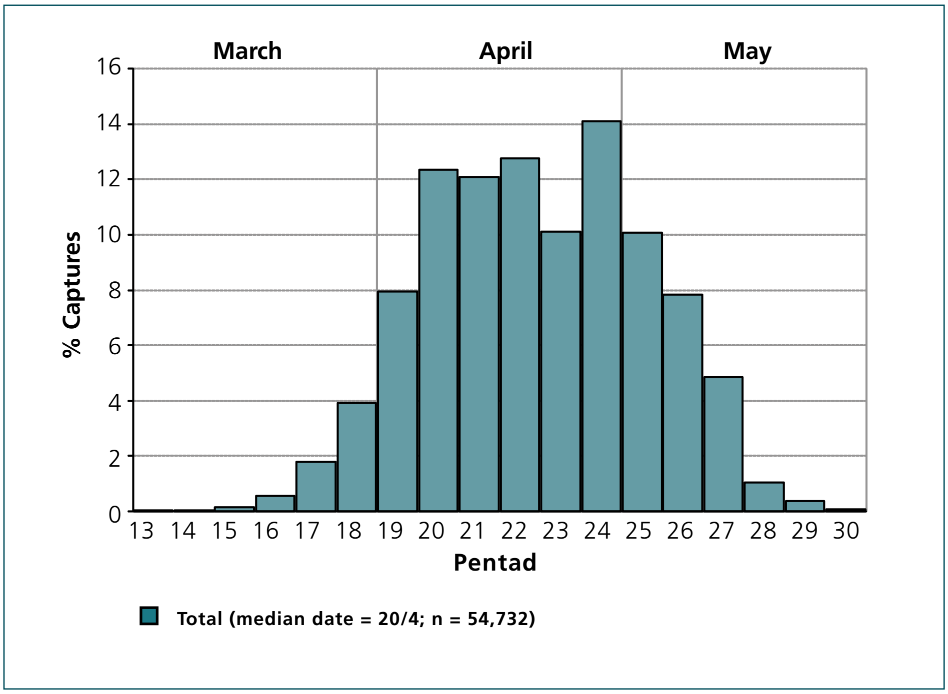


Figure 3. Frequency of captures during the study period.

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

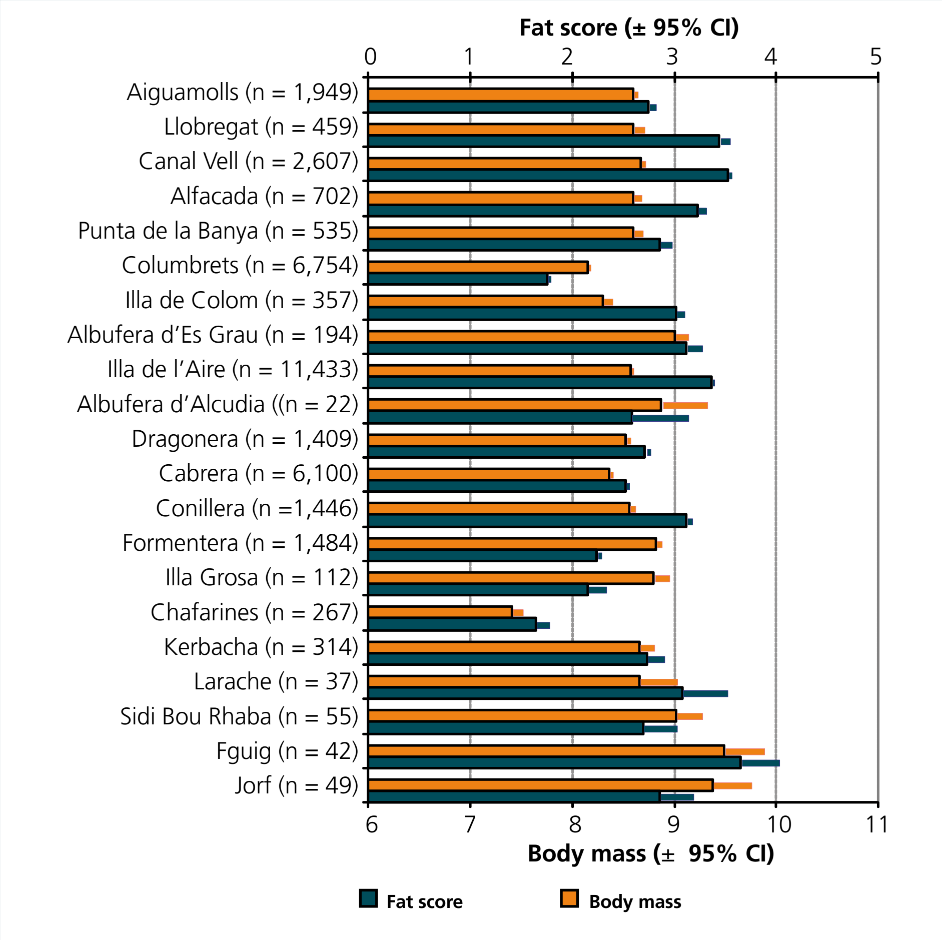
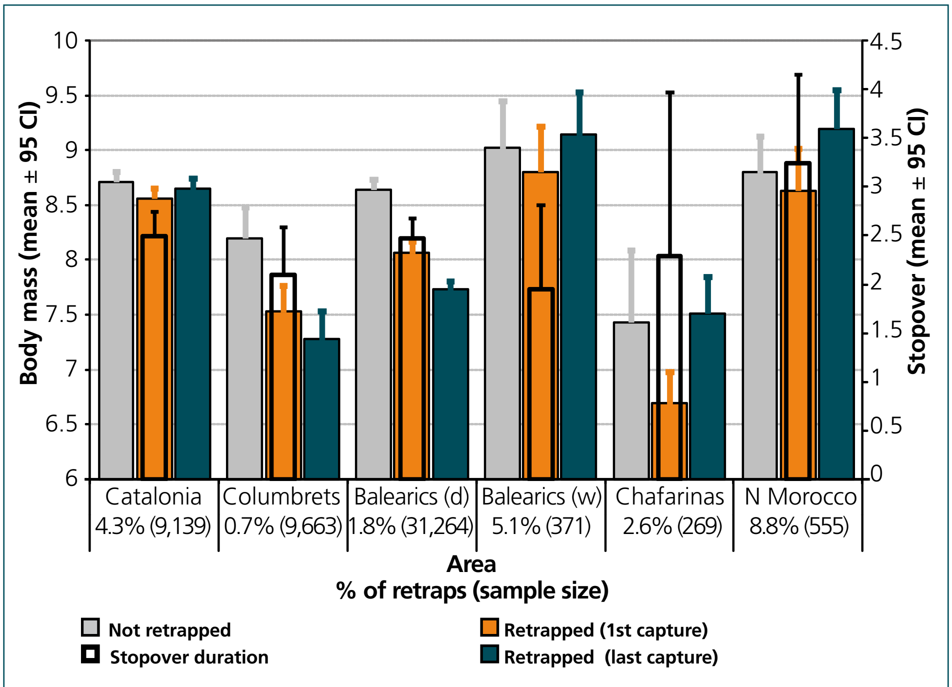


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



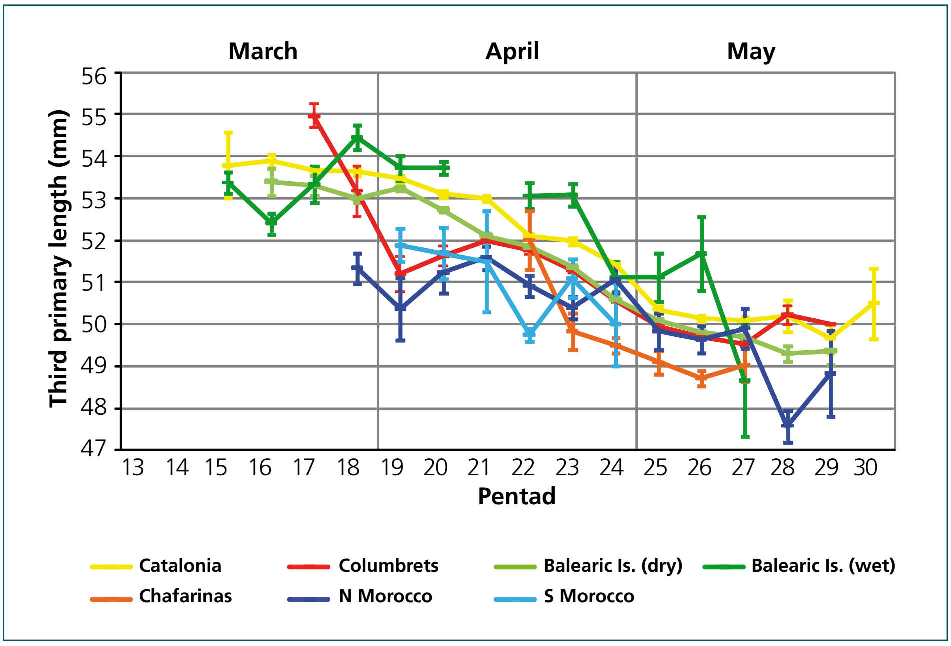


Figure 6. Temporal variation of third primary length according to area.

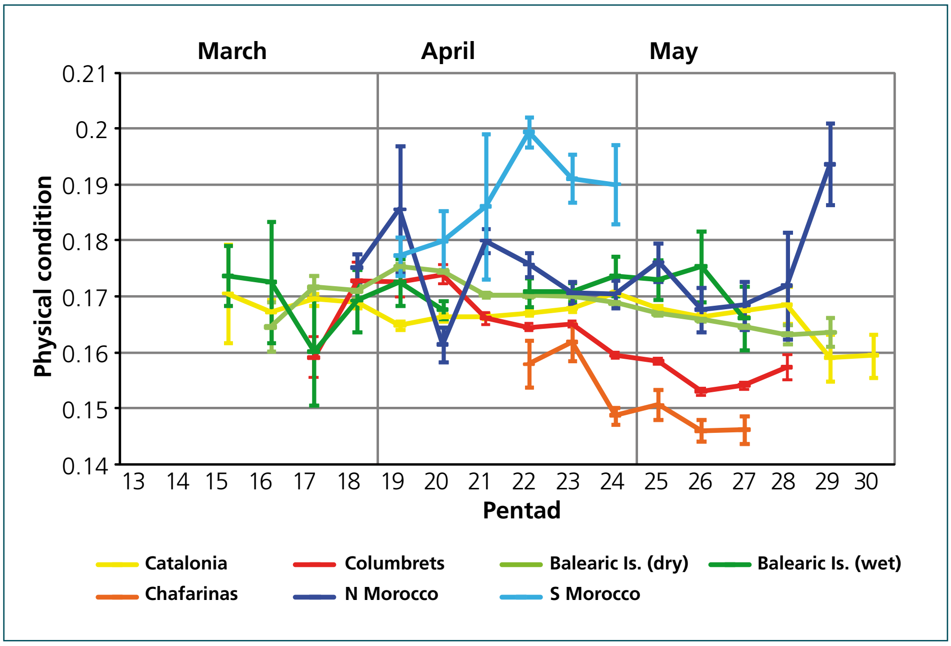


Figure 7. Temporal variation of physical condition according to area.

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

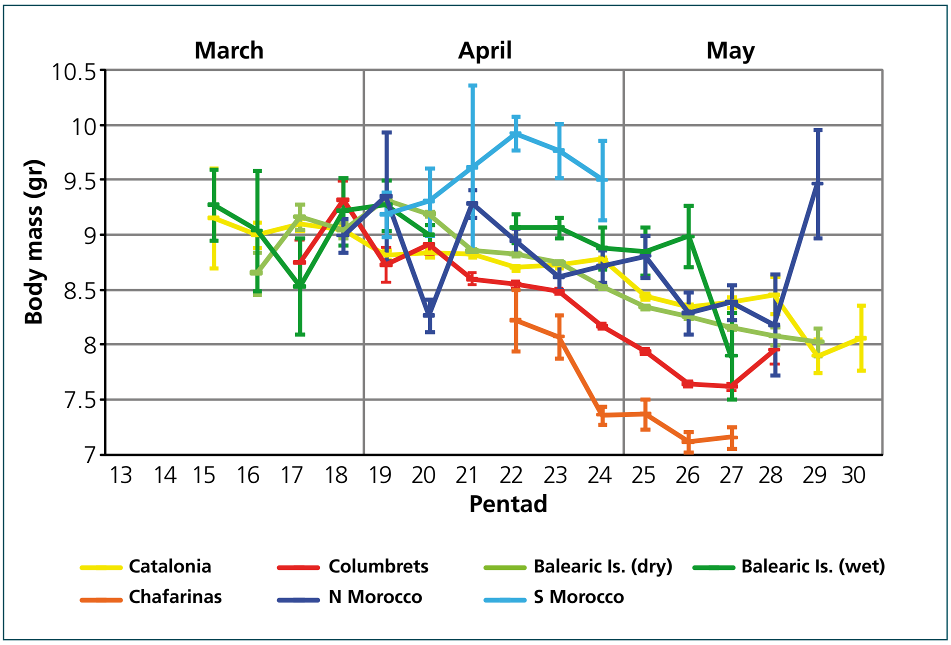
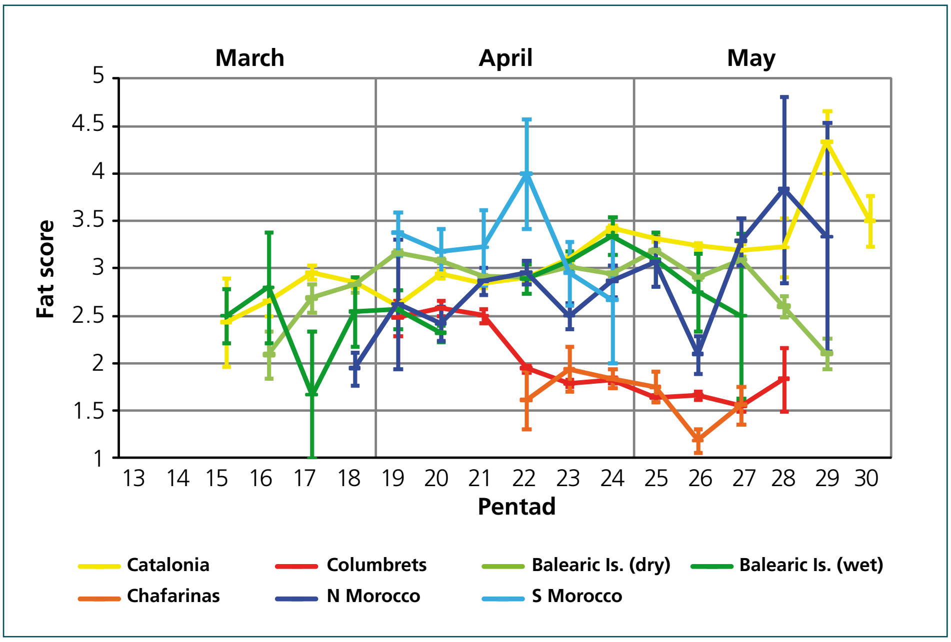


Figure 9. Temporal variation in fat score according to area.



Spotted Flycatcher
Muscicapa striata

José Luís Martínez

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.

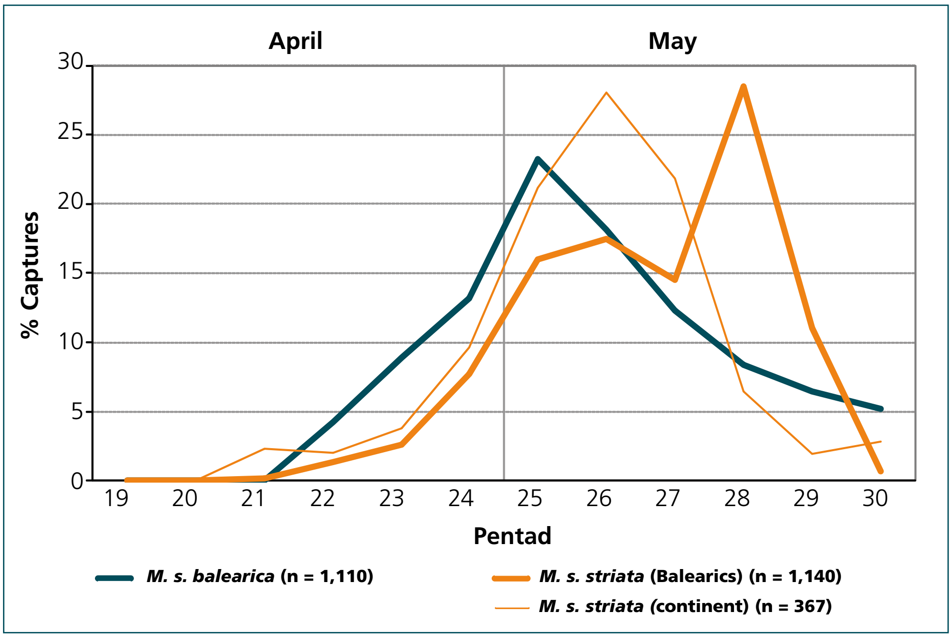


Figure a. Temporal variation in the frequency of captures of *M. s. striata* and *M. s. balearica*.

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)			

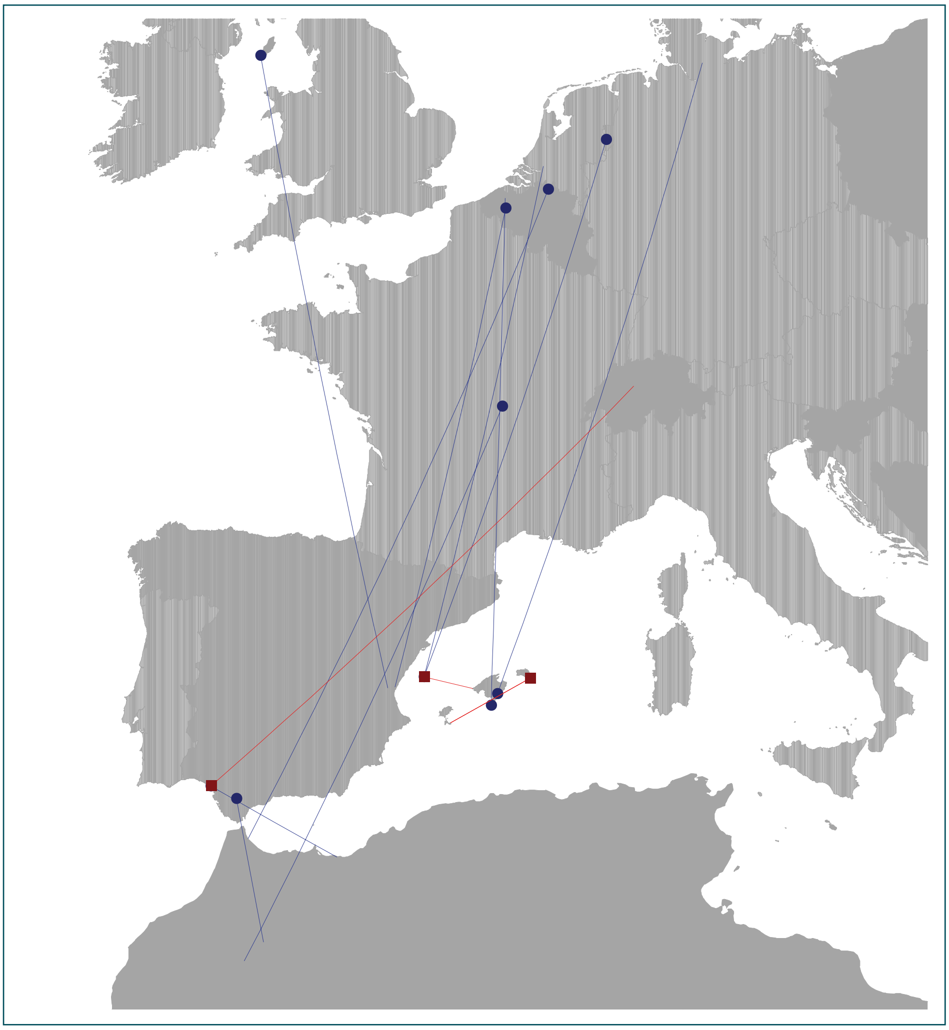


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

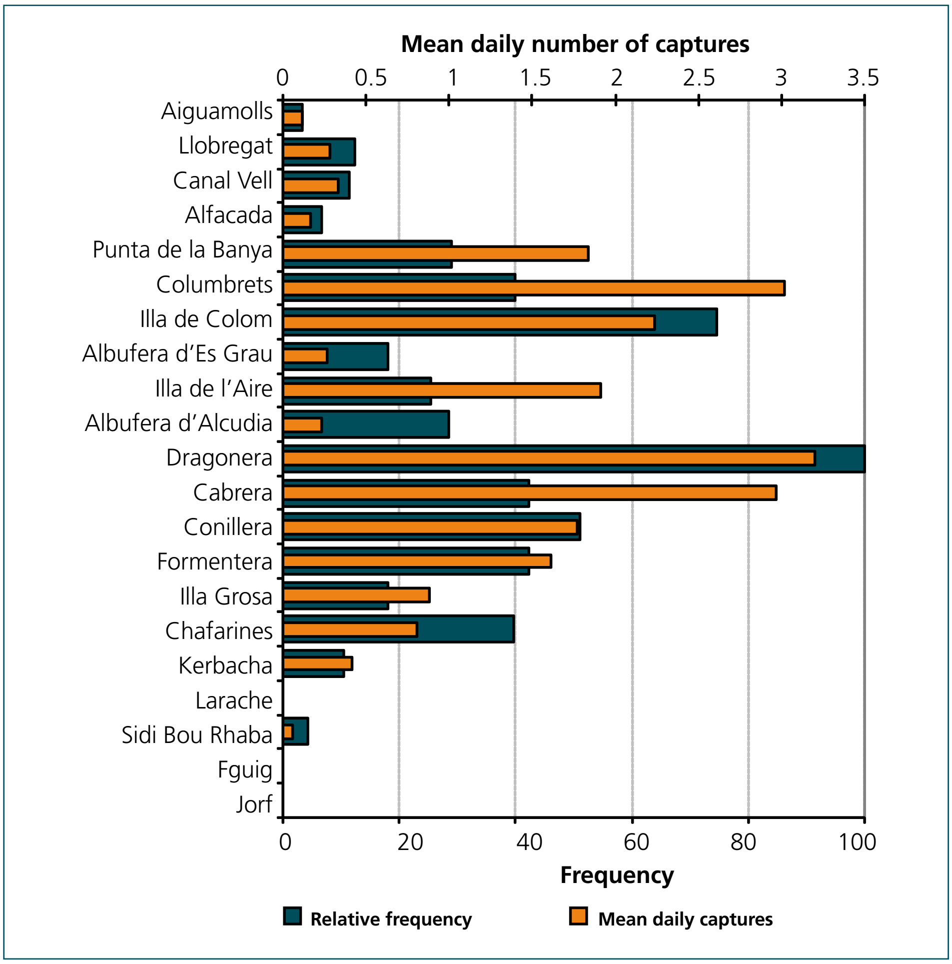


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

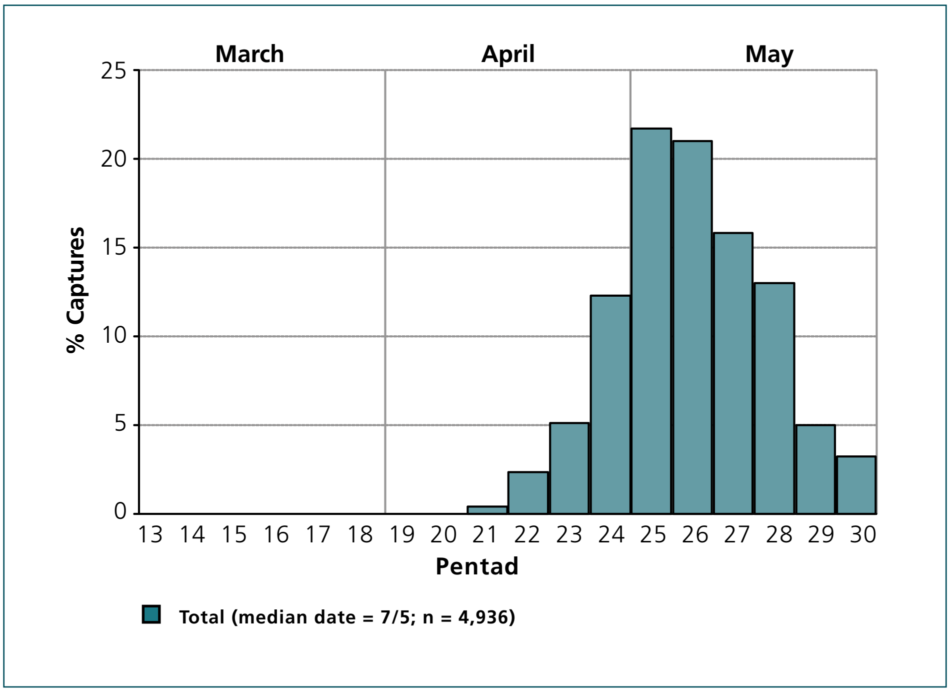


Figure 3. Frequency of captures during the study period.

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

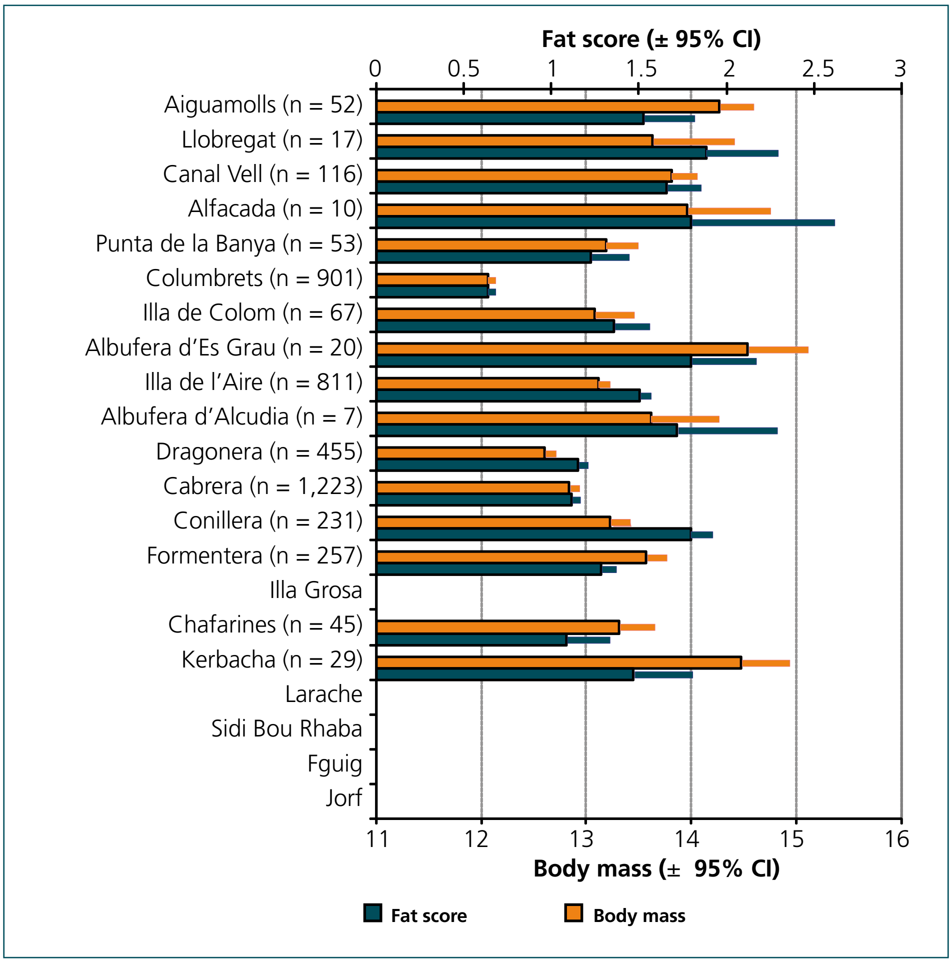
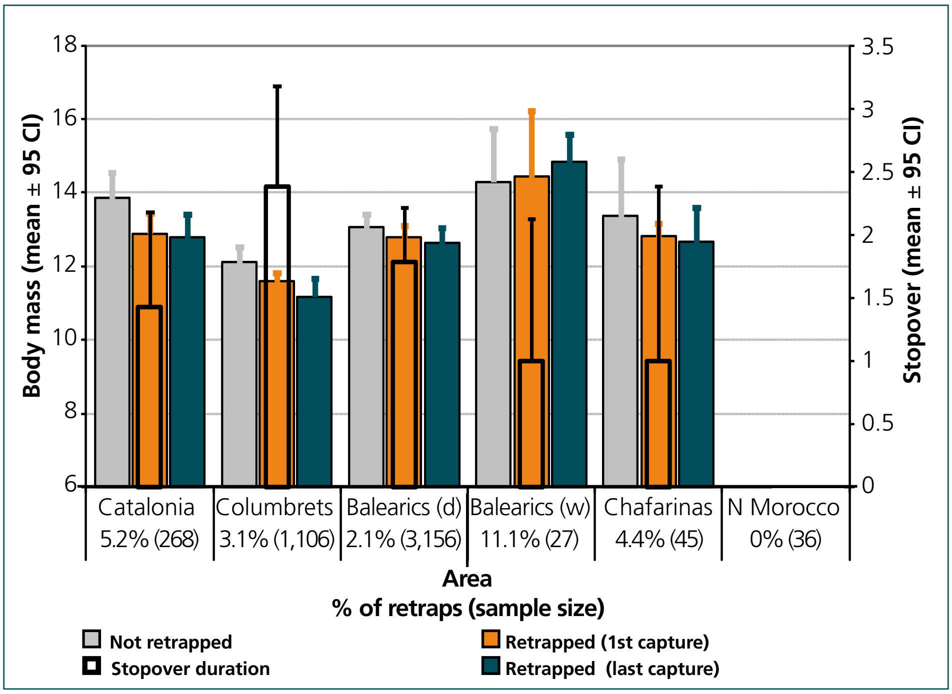


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



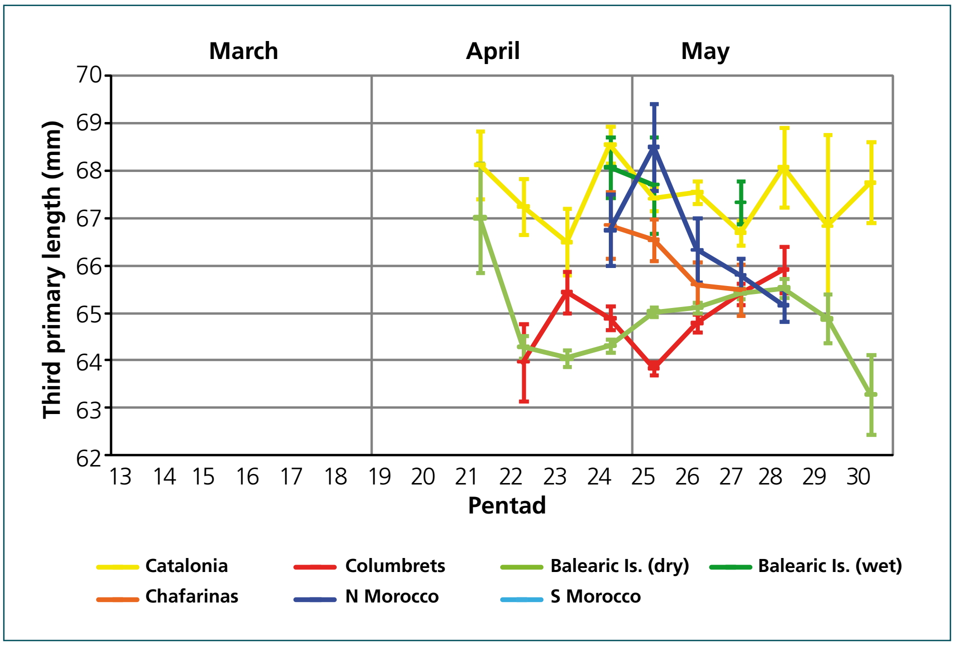


Figure 6. Temporal variation of third primary length according to area.

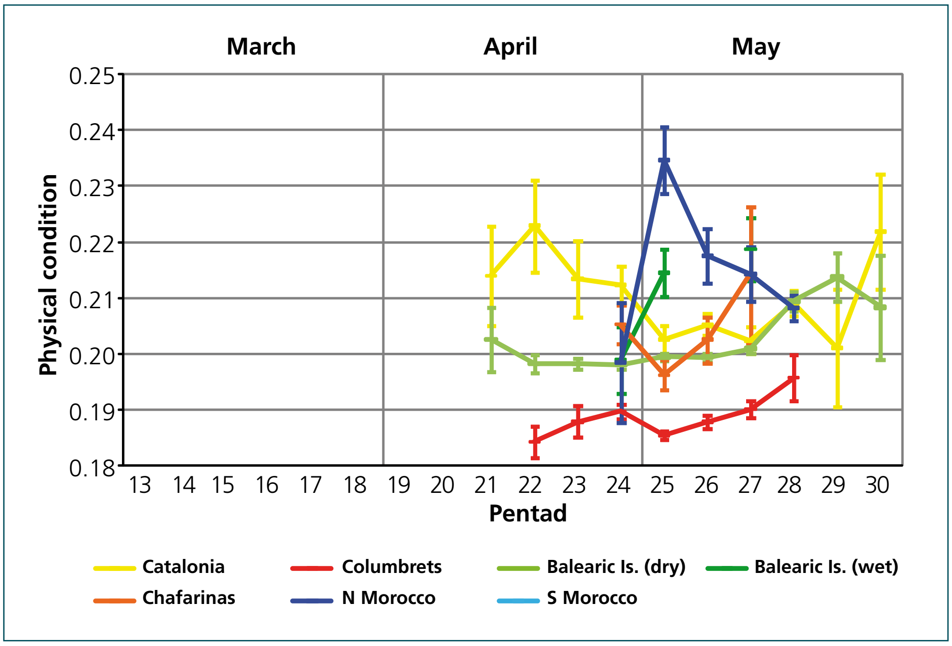


Figure 7. Temporal variation of physical condition according to area.

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

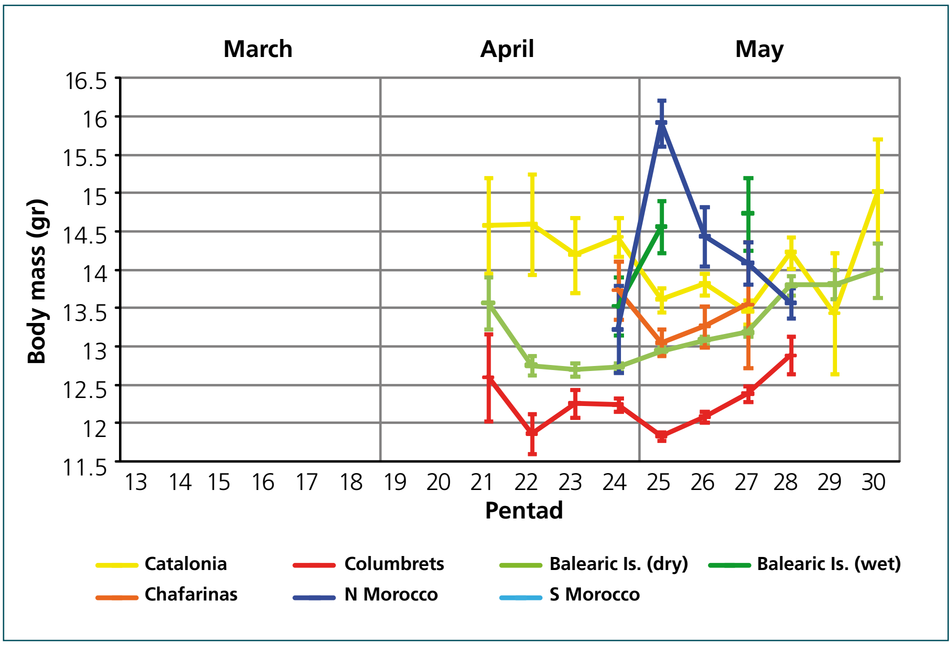
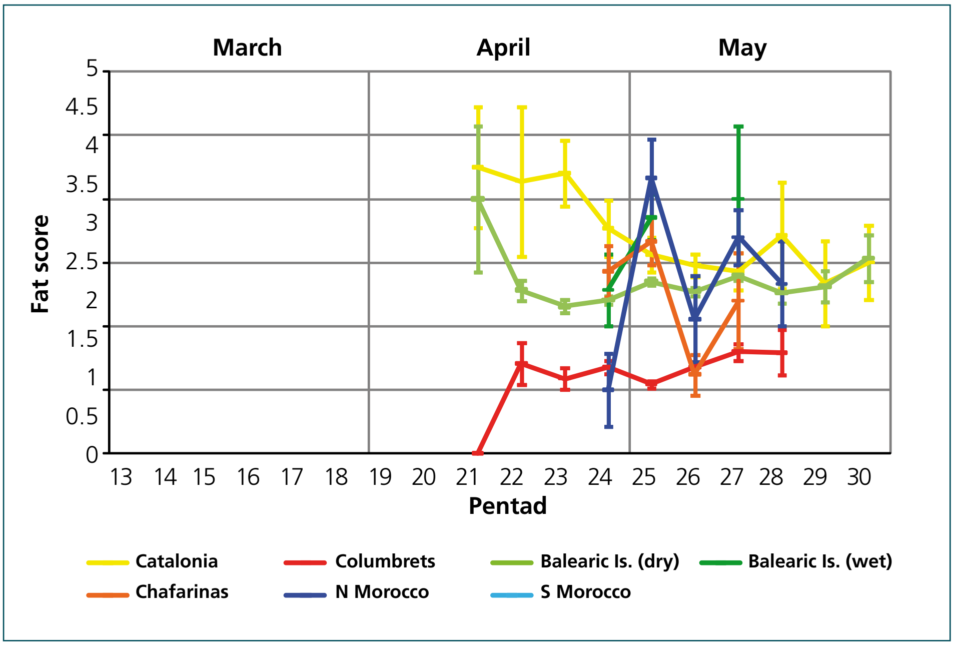


Figure 9. Temporal variation in fat score according to area.



Pied Flycatcher
Ficedula hypoleuca

Hamid Rguibi-Idrissi

Range

The Pied Flycatcher's breeding range covers most of C and N Europe eastwards to W Siberia and scattered parts of NW Africa, Britain, France and Iberia (Glutz von Blotzheim & Baeur, 1991; Lundberg & Alatalo, 1992). Its wintering areas lie in western tropical Africa, mostly north of the Gulf of Guinea to *c.* 11°N, and from Guinea and Gambia eastwards to the Central African Republic (Moreau, 1972; Urban et al., 1997; Cramp, 1998). It does not breed in any of the study sites. Although two rather distinct subspecies do breed in Iberia and Morocco (*iberiae* and *speculigera*, respectively; Saetre et al., 2001), the vast majority of captures reported here refer to the nominate race.

Migratory route

Birds migrating though the area in spring originate from a wide area ranging from Britain and C Europe, north to Scandinavia and eastwards to the Baltic and W Russia (fig. 1). Passage through the study area takes place following a main SW-NE direction, except for birds originating from Britain, which move due N. These results agree with the well-known migratory route of this species through Europe and N Africa (Zink, 1985; Cramp, 1998; Rguibi-Idrissi, 2002; Spina & Volponi, 2009). Spring passage takes place distinctly further east than in autumn in a text-book example of loop migration (Zink, 1985; Newton, 2008). Accordingly, in Iberia most autumn recoveries take place in the centre and west of the Peninsula (Telleria et al., 1999), while in Morocco the main autumn passage occurs along the western Atlantic coast (Rguibi-Idrissi, 2002; Thévenot et al., 2003). In spring, on the contrary, the recovery and capture data presented here indicate that this species is very common along the Mediterranean Spanish coast and the Balearics (figs. 1, 2), and commoner along the Mediterranean coast of Morocco and inland than on the Atlantic coast (as also indicated by Rguibi-Idrissi, 2002; Thévenot et al., 2003).

The species seems to stop relative more frequently in NW Africa in spring than in autumn, increasingly so to the east. In Morocco, most recoveries are from spring (243 against 105 in autumn; Moroccan Bird Ringing Centre, unpubl. data), although observations are frequent in both seasons (Thévenot et al., 2003); in Algeria and Tunisia, however, the vast majority of recoveries take place in spring and the species is markedly more common then than in autumn (Dejonghe & Cournet, 1982; Isenmann & Moali, 2000; Isenmann et al., 2005). In SW Europe the reverse is observed, recoveries being much more common in autumn than in spring (Cramp, 1998; Telleria et al., 1999). The notable passage and abundance of recoveries along the entire Mediterranean coast of N Africa indicates that the species crosses the W and C Mediterranean along a broad front (*cf.* also Spina & Volponi, 2009).

Phenology

The first individuals migrate through the area in early April, with passage progressively reaching a peak in late April and early May, and then decreasing steadily afterwards (fig. 2). The pattern is very similar in Catalonia and the Balearics/Els Columbrets, but with a peak in mid-April in N Morocco. Birds on passage can still be seen in the area in early June, outside the study period (Telleria et al., 1999; Thévenot et al., 2003). Overall, the phenological pattern in the C Mediterranean is very similar to that shown here, with the median date of passage on Capri (1 May) being nearly identical (Pettersson et al., 1990; Spina et al., 1993). At Gibraltar and N Morocco passage can start in mid- or late March, although not usually until April (Finlayson, 1992; Thévenot et al., 2003), while in S Morocco it occasionally starts in early March, but mostly also occurs from early April onwards (Thévenot et al., 2003; Gargallo et al., unpubl.).

Males pass distinctly earlier than females (differences in median dates 10 and 9 days in adults and second-year birds, respectively), but adults only slightly earlier than second-year birds (3 and 2 days earlier in males and females, respectively). These sex and age-related phenological differences are well documented during both migration and on arrival at breeding grounds (Dornbusch, 1981; Dejonghe & Cornuet, 1982; Cramp, 1998; Messineo et al., 2001; Rguibi-Idrissi, 2002). However, sexual differences in passage may be less accentuated in the C Mediterranean, since medians differ only by 4 and 6 days in adults and second-year birds, respectively (Petterson et al., 1990). Recoveries show that the further north birds are ringed/recovered, the later they pass through the study area, indicating that northern populations tend to delay their passage.

Biometry and physical condition

Mean values for third primary lengths range from 60.4 in N Morocco to 61.5 in the wet Balearics and S Morocco, figures that are very similar to those reported in the C Mediterranean (Messineo et al., 2001; table 1). Mean values for wing length vary from 78.2 in N Morocco to 79.7 in the wet Balearics, also similar to those obtained in other sites in the C Mediterranean (Rubolini et al., 2004, Waldenström et al. 2004) and C and N Europe (Cramp, 1998). Wing length clearly decreases over time, which probably reflects the later passage of shorter-winged females (Cramp, 1998) (fig. 6). The same trend can be seen on the Tyrrhenian islands (Spina et al., 1993). Interestingly, birds trapped in the wet Balearics have significantly longer third primaries than in the dry Balearics (also when considering only males).

Fat reserves are significantly lowest in the dry Balearics and, especially, Els Columbrets, and highest in Catalonia, S Morocco and the wet Balearics (table 1, fig. 8).

Physical condition, on the other hand, is distinctly higher in N Morocco and the wet Balearics; in the dry Balearics and Catalonia figures are similar and are clearly better than in Els Columbrets. Fat tends to increase with time in the Balearics and N Morocco and physical condition in the Balearics and Catalonia (figs. 7, 9). These increasing trends suggest that later arriving birds (more females) migrate in slightly better condition, possibly due to being in less of a hurry to migrate faster or to the better environmental conditions encountered as the season progresses en route and/or at wintering/fattening grounds. Mean body mass varies from 10.6 in Els Columbrets to 12.3 in S Morocco, but with no clear overall trend (fig. 9). It decreases significantly with time in S Morocco, but in the dry Balearics it increases, albeit only slightly. Averages are highest in S and N Morocco, and lowest in the dry Balearics and, above all, on Els Columbrets. Birds from the wet Balearics are significantly heavier than on the other islands. Body mass on Els Columbrets and the dry Balearics is similar to that reported from the Tyrrhenian islands (10.8, n = 1,172; Spina et al., 1993), while the average from Catalonia is very similar to that obtained at Gibraltar (11.5, n = 28; Finlayson, 1981) and further north in Switzerland (11.9, n = 42; Cramp, 1992). Birds from N Morocco have a similar average to N Tunisia (mean 12.3, n = 67; Waldenström et al., 2004), but those from S Morocco are slightly heavier than those reported at the nearby sites of Defilia (11.6, n = 60; Ash, 1969) and Merzouga (11.6, n = 101; Gargallo et al., unpubl.).

As birds trapped in N Morocco are at most only slightly heavier than in the south, mass gain in the area seems to be globally rather limited. In Catalonia birds are only in slightly poorer body condition than in N Morocco and show similar mass to those from S Iberia and C Europe, suggesting that once in continental Europe the species migrates in short bouts that do not require long stopovers or significant new gains in mass. Only birds passing through Els Columbrets and the Balearics show markedly poorer body condition, a sign of the efforts undertaken while crossing the sea. In the wet Balearics, however, birds are significantly heavier, have larger fat reserves and longer wings than on the other islands, where apparently a higher proportion of birds in poor body condition are attracted to land. The fact that these birds also have on average shorter wings suggests that smaller size may make them more prone to suffer from unfavourable meteorological circumstances (particularly strong head winds; *cf.* Newton, 2008; Saino et al., 2010) and thus be more inclined to stop at any available site. Birds stopping at wetlands on larger islands may also gain mass faster and include a larger proportion of birds that have been at the site for a few days (either at the site itself or other surrounding areas), which may also contribute to the overall better average body condition in these places.

Stopover

The percentage of retraps is low in all areas except N Morocco, where totals attain *c.* 18% of birds (fig. 5, table 2). Mean stopover lengths are in the range 2-4 days and are not markedly different in any area in particular. Birds staying in the dry Balearics are in poorer condition when first captured than those not trapped again, indicating that a higher proportion of birds in poor condition end up staying at these sites. When considering all the retraps, bird tend to show negative fuel deposition rates (although only significantly so on Els Columbrets) and nearly so in the dry Balearics. If one-day retraps are excluded, rates become positive at all sites except Els Columbrets, although never significantly so. The high number of retraps in N Morocco coincides with its expected role as a relevant stopover area; however, as shown by biometrical data no clear pattern of mass gain is observed.

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	1,729	79.6 ± 1.8 (72.0-87.0)	61.4 ± 1.6 (54.5-66.5)	11.9 ± 1.1 (8.8-16.4)	2.0 ± 1.1 (0-5)
Columbrets	468	79.8 ± 2.3 (72.0-85.0)	60.9 ± 1.7 (54.5-68.0)	10.6 ± 1.1 (7.3-15.3)	0.7 ± 0.8 (0-5)
Balearics (dry)	4,356	78.9 ± 2.0 (72.0-87.0)	60.7 ± 1.8 (54.5-68.0)	11.5 ± 1.2 (6.2-16.5)	1.6 ± 1.1 (0-6)
Balearics (wet)	100	79.7 ± 1.6 (76.0-83.0)	61.5 ± 1.5 (57.0-65.0)	12.2 ± 1.5 (8.0-16.0)	2.4 ± 1.1 (0-5)
Chafarinas	9		60.5 ± 1.5 (58.5-62.5)	11.1 ± 1.1 (10.0-13.5)	1.2 ± 1.0 (0-3)
N Morocco	90	78.2 ± 1.9 (74.0-82.5)	60.4 ± 1.6 (56.0-64.5)	12.2 ± 1.3 (8.5-16.5)	2.0 ± 1.3 (0-5)
S Morocco	88	79.6 ± 1.9 (76.0-84.0)	61.5 ± 1.5 (58.5-64.5)	12.3 ± 1.1 (10.0-15.1)	2.2 ± 1.0 (1-4)

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	-0.08 ± 0.10 (97)	-0.29 ± 0.18 (18)	-0.06 ± 0.06 (277)			-0.07 ± 0.33 (16)
Retraps > 1 day	0.05 ± 0.10 (46)	-0.03 ± 0.21 (8)	0.04 ± 0.06 (165)			0.14 ± 0.26 (8)

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

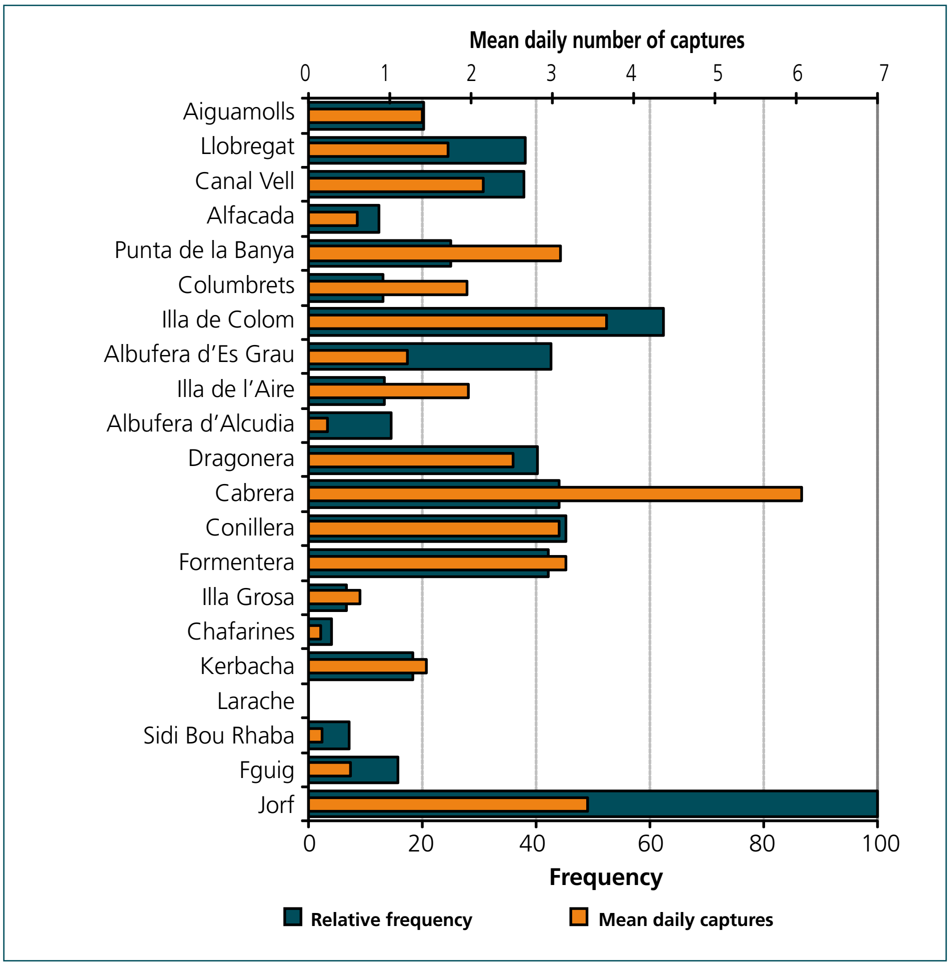


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

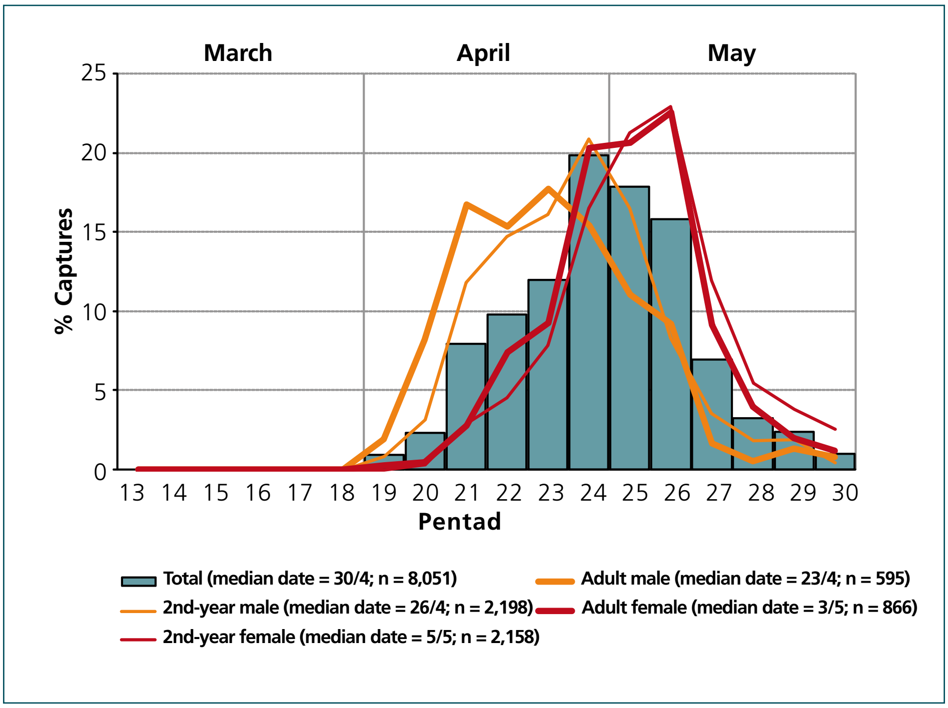


Figure 3. Frequency of captures during the study period.

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

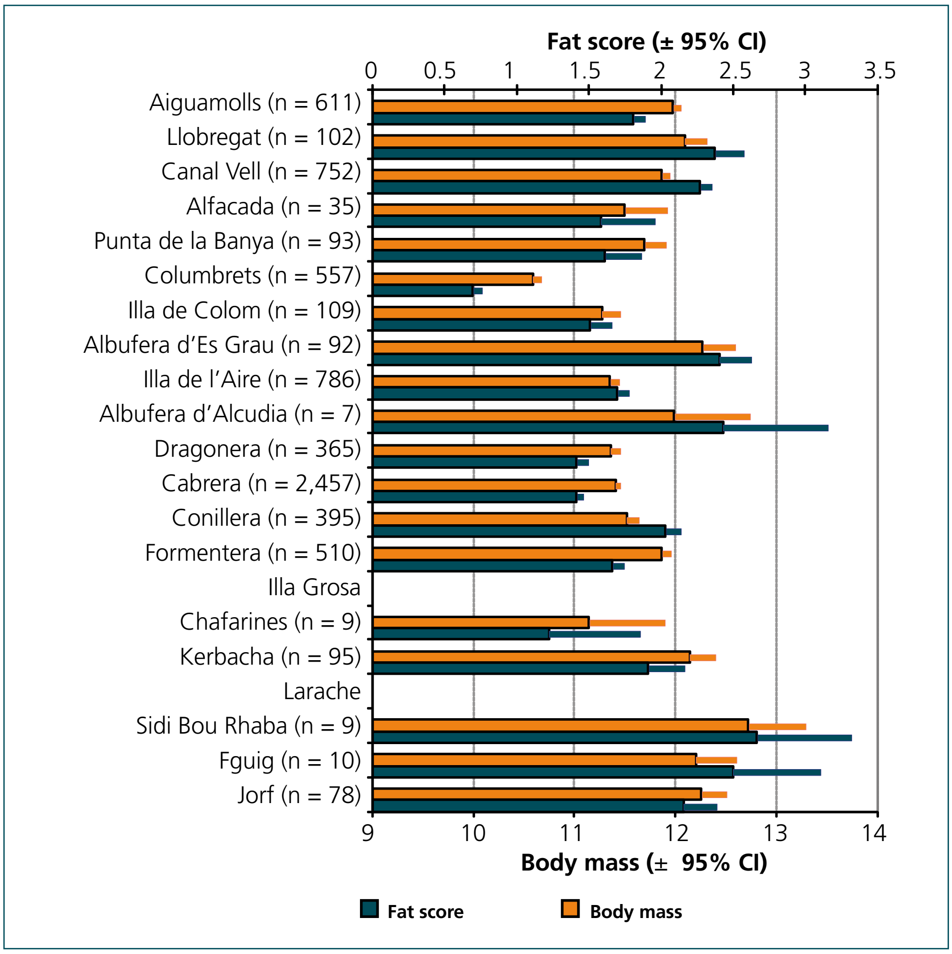
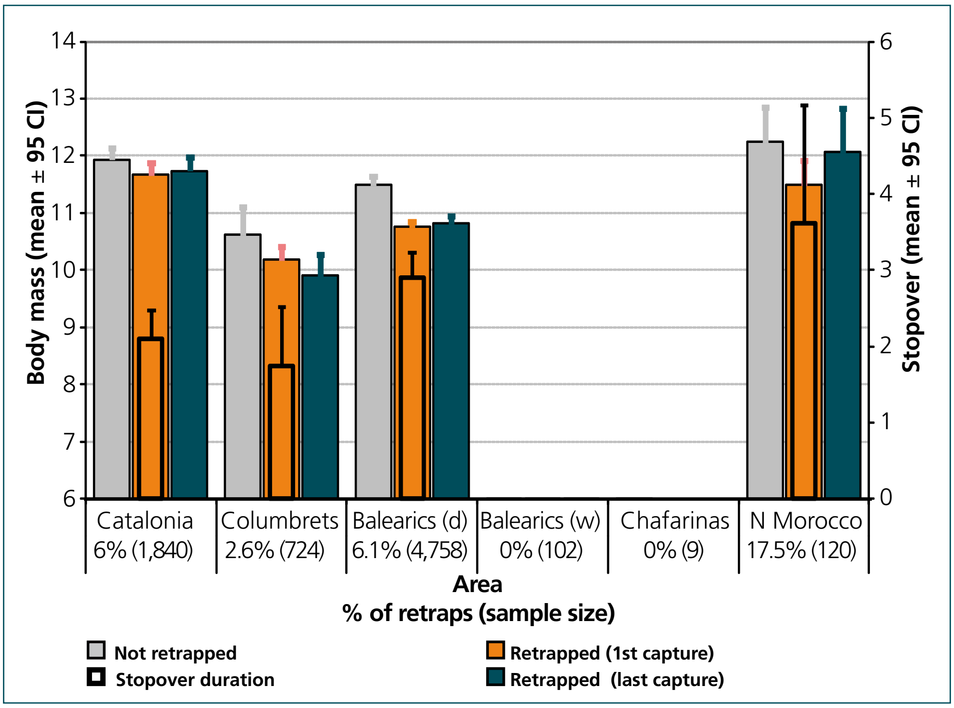


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



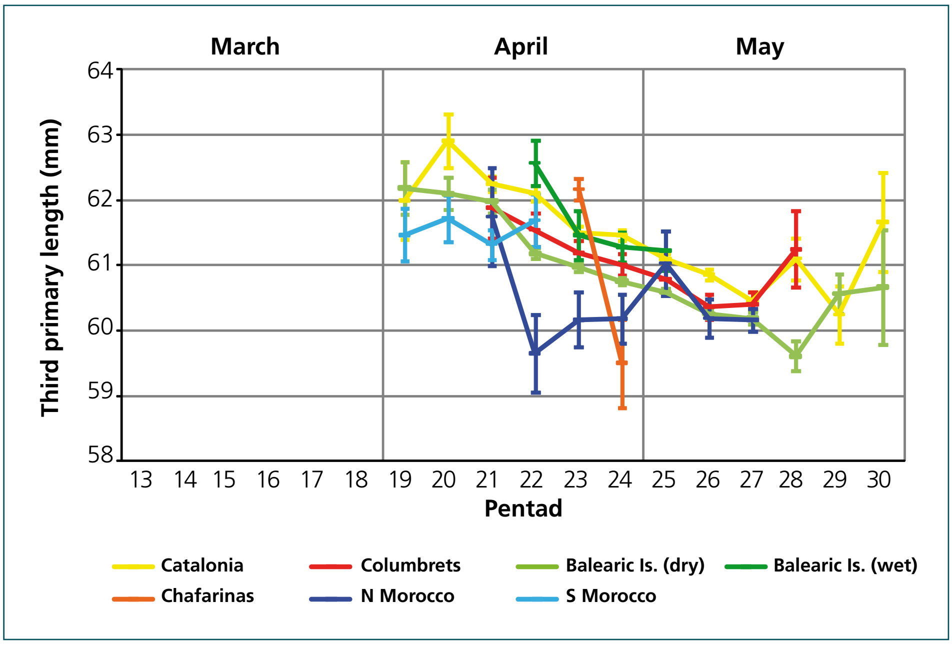


Figure 6. Temporal variation of third primary length according to area.

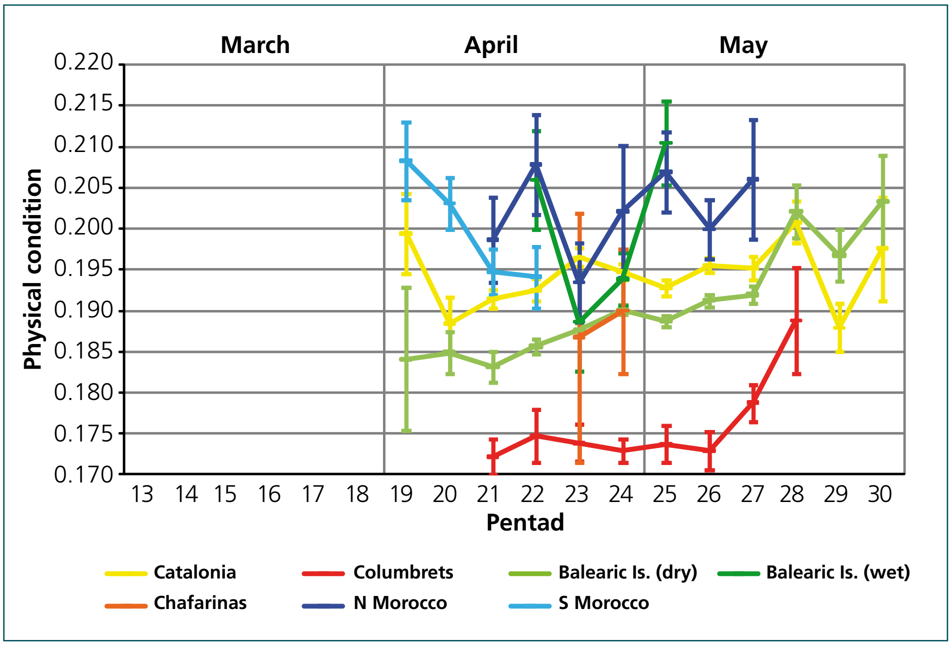


Figure 7. Temporal variation of physical condition according to area.

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

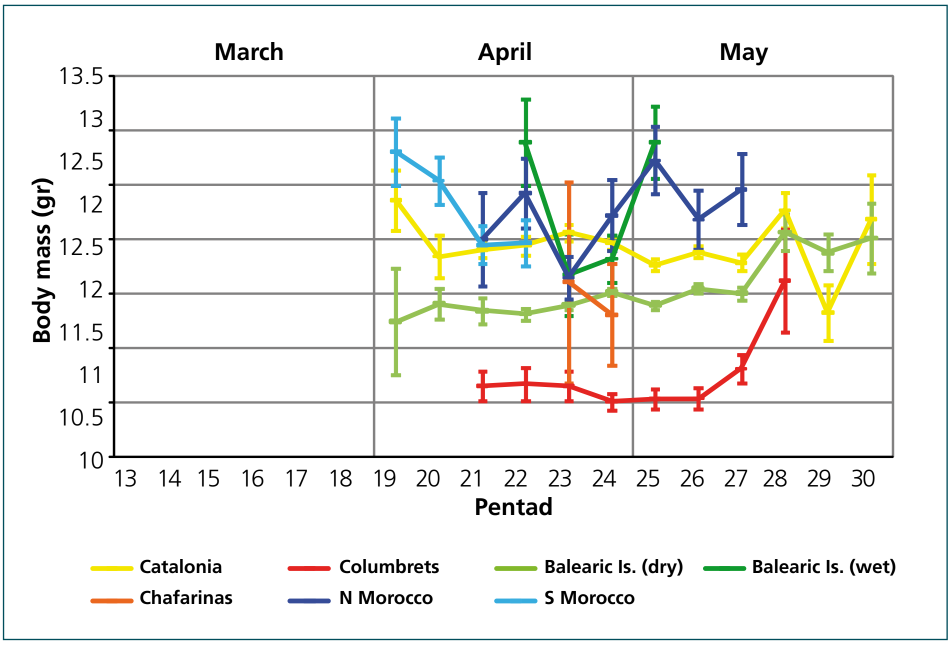
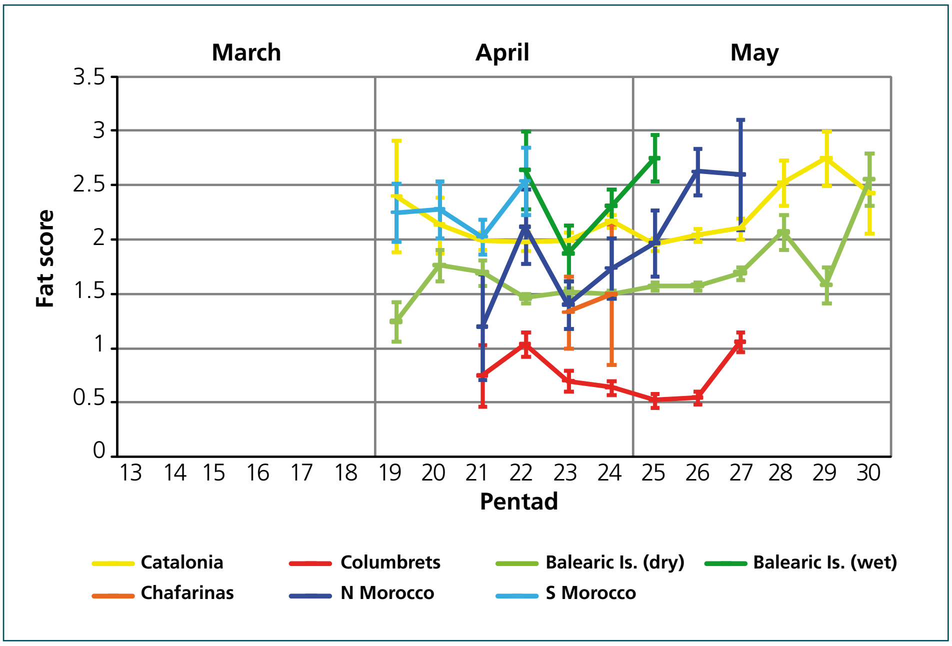


Figure 9. Temporal variation in fat score according to area.



Woodchat Shrike
Lanius senator

Óscar García

Range

The breeding range of the Woodchat Shrike is largely restricted to NW Africa and Mediterranean Europe, and then eastwards to the Caucasus and Iran and with some scattered populations in C Europe and Cyrenaica (Cramp, 1998). Four races are recognized: the nominate *senator* inhabiting most of the mainland Europe; *rutilans* from Iberia and NW Africa; *badius* endemic to the Balearic Islands, Sardinia and Corsica; and *niloticus* in Cyprus and Levant and eastwards (Cramp, 1998; Harris & Franklin, 2000). Compared to the nominate race, *rutilans* is distinctly smaller, while *badius* is slightly larger (Cramp, 1998; own data). Except for a few birds wintering in SW Arabia, all populations winter in sub-Saharan Africa, north of the equator as far as the Sahel; western races winter eastwards to the extreme west of Sudan (Cramp, 1998).

This shrike breeds in the study area, but at the specific ringing sites only on the Balearics at all sites except the smallest islands (L'Illa de l'Aire, Colom, Cabrera and Conillera) and very locally at Els Aiguamolls. Even at these ringing sites, the vast majority of captures are of non-local migrants.

Migratory route

The few recaptures available suggest that the main movements follow a SW-NE direction (fig. 1). Two direct recoveries consist of one bird breeding on Menorca captured on Cabrera 39 days before and another ringed in the Ebro delta and recovered 11 days later in S France. Another recovery suggests some inter-annual variability in migratory routes, since it was ringed in Mallorca in one spring and then in Tunisia in the next. The spring migration of western populations take places further to the east and is thus more direct than in autumn (Zink, 1975; Cramp, 1998). In the C Mediterranean, in spring birds move much more in a due N direction, using a somewhat more westward route in spring than in autumn (Spina & Volpini, 2008). In NW Africa, this species is widespread in spring, and much more common than in autumn (Cramp, 1998; Thévenot et al., 2003).

Apart from Els Columbrets and the Balearic Islands the vast majority of captures are of either the nominate race or *rutilans*. Difficulties in separating these races prevent a more detailed account, but data on wing-length (see below) suggests that *rutilans* is not common in Catalonia but clearly is in Morocco. In both areas a few *badius* are trapped (present data; Ash, 1969; Thévenot et al., 2003). In the Balearics about one third of all captures are of *badius* and the rest of *senator* (and perhaps some *rutilans*). The exact racial composition of captures on Els Columbrets is unknown, but is apparently similar to that observed in the Balearics. The eastern race *niloticus* occurs only very rarely in the Balearics.

Present data and that from C Mediterranean (Zink, 1975; Spina & Volpini, 2008) indicate that birds cross the region in broad front. Captures are quite common at both continental and insular sites (fig. 2). Quite large numbers from L'Illa Grossa, L'Alfacada and La Punta de la Banya, however, suggest that coastal islands and peninsular sites attract more birds than continental areas. In Morocco, the highest numbers occur in the south.

Phenology

Migration through the area takes place from mid-March to the end of May, but mostly from early April to mid-May (fig. 3). Some birds are certainly still on passage in early June (*cf.* Telleria et al., 1999). The overall pattern of passage is obscured by important differences between subspecies. The nominate race (including an unknown number of *rutilans*) migrates distinctly later than *badius* (median date 13 days later according to present dataset) (fig. a). Peak passage in *badius* takes place in mid-April, but from late April to early May in *senator.* In Italy phenological differences between these subspecies are apparently less pronounced (Fracasso et al., 1995).

Our data from Morocco are too scarce and limited to allow a detailed comparison with Catalonia and Els Columbrets/Balearic Islands, although other information indicates that in this area the passage of *senator* takes place somewhat earlier than shown here. In S Morocco it occurs from February onwards, but mostly from mid-March to mid- or late April in the SE and in the N of the country mostly from late March onwards (Smith, 1968; Thévenot et al., 2003; Gargallo et al., unpubl.). North of the Strait at Gibraltar the main passage period is in April (Finlayson, 1992). Passage through the C Mediterranean is also complicated by the involvement of different races, although considering the species as a whole the pattern is rather similar to that described here (Spina et al., 1993; Fracasso et al., 1995).

Males migrate only slightly earlier than females in both senator and badius (median dates differing by only 3 and 1 days, respectively; fig. 3). Adults also migrate somewhat earlier than second-year birds (median dates differing by 2 and 8 days, respectively). Both age-related and, above all, sex-related differences are minor as per published information regarding spring migration and arrival at breeding grounds (Fracasso et al., 1995; Cramp, 1998).

Biometry and physical condition

Mean values for third primary lengths range from 71.9 in Chafarinas to 76.5 in the wet Balearics (table 1). Mean values for wing lengths vary from 94.5 in N Morocco to 101.3, also in the wet Balearics. Reported figures for the C Mediterranean (Spina et al., 1993; Cramp, 1998; Waldenström et al., 2004) are distinctly higher except when compared to the wet Balearics and to data exclusively for *badius*. This difference is due to the lack of captures of the smallest race *rutilans* in this area and to the fact that *senator* populations passing through there are larger (present data; Fracasso et al., 1995).

There is a marked and significant temporal decrease in third primary length in the dry Balearics, where most birds are trapped (fig. 6). In this species, sexual and age-related size dimorphism is inexistent or at best very slight (own data; Fracasso et al., 1995; Cramp, 1998) and phenological differences in relation to sex and age are minor (see above). Therefore, at least to a large degree, this trend should reflect the temporal variation in racial composition (see above), the proportion of smaller nominate birds becoming progressively higher as the season progresses. Interestingly, however, when considering only *badius* this decreasing trend is still significant and equally noticeable in the dry Balearics and birds progressively go from an average third primary length of *c.* 76-77 in late March to 73-74 in mid-May. We have no clear explanation for this trend. A temporal decrease in size, albeit less pronounced, is also reported from the Tyrrhenian islands (Spina et al., 1993), although since *badius* is also present there, it is not clear whether this pattern also prevails at subspecific level.

Mean values for fat scores vary between 0.4 on Las Chafarinas and 2.5 in Morocco, while mean body mass varies from 26.1 in S Morocco to 31.6 in the dry Balearics (37.1 in the wet Balearics; table 1). Globally, body mass, fat and physical condition tend to decrease with time (figs. 7-9). These trends, however, seem to be influenced again by temporal variations in racial composition since they disappear when analysing the data at the subspecific level.

Fat reserves are somewhat higher in N Morocco than further north in Catalonia and the dry Balearics (*senator*), but average body mass is similar in all three areas, indicating that birds can regain mass fairly easily en route. Larger size and body mass in the wet Balearics is largely due to the fact that most birds trapped there are *badius*. Only birds trapped at a very few specific sites show distinctly low body mass and fat reserves (fig. 4). This is the case on Els Columbrets, the most isolated and distant islands, and La Punta de la Banya and Las Chafarinas, which apparently mostly attract birds with poorer body condition forced to land at the first available site. Given their situation, a mere 3-4 km from the N Moroccan coast, a good number of the birds stopping at Las Chafarinas may be birds on reverse migration. At Gibraltar, just after crossing the strait, reported mean body mass is also likewise lower than at these latter sites (mean 29.0, n = 17; Finlayson, 1981).

Birds trapped in S Morocco are in the worst condition in terms of body mass and physical condition (table 1, figs. 7-8). The two study sites (operated in different years) show similarly low figures; however, higher average body mass have been reported in other years from nearby areas: 29.3 at Defilia (n = 68; Ash, 1969) and 28.4 at Merzouga (n = 92; Gargallo et al., unpubl.). Accordingly, and depending on the year and site, body mass in SE Morocco is *c.* 4-17% lower than in N Morocco, indicating that some refuelling takes place after crossing the Sahara. Similar behaviour is observed in Tunisia, where birds trapped at Gabès near the Saharan border are *c.* 10% lighter than *c.* 300 km further north (Castan, 1960; Waldenström et al., 2004).

Stopover

The percentage of retraps and stopover lengths are rather low (somewhat higher in the wet Balearics probably due to the inclusion of local breeding birds; fig. 5, table 2). There are no significant differences in the average initial body mass between retrapped and non-retrapped birds. Although biometrical data strongly indicates that birds can refuel either in NW Africa or en route through Europe and the islands, stopover data fail to reveal any clear pattern as fuel deposition rates are not significantly different from zero in all cases. This lack of correspondence is probably due to methodological drawbacks. In S Tunisia and SE Morocco other studies show that birds certainly fatten up to some degree during their stay of up to 16 days in the area (Castan, 1960; Ash, 1969; Gargallo et al., unpubl.).

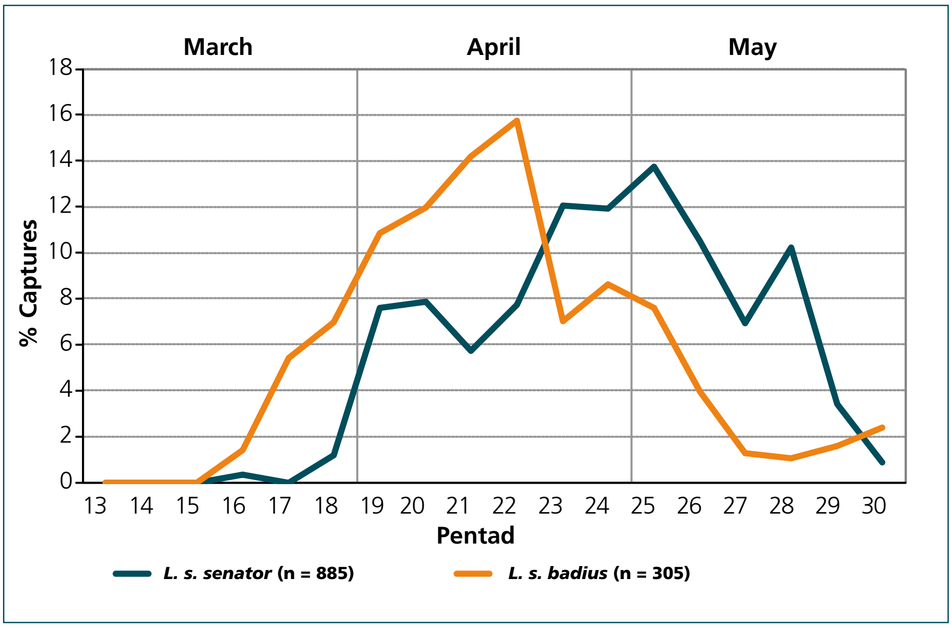


Figure a. Temporal variation in the frequency of captures of *L. s. senator* and *L. s. badius* (data from the Balearic islands only).

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

	n	Wing	Third primary	Body mass	Fat score
Catalonia	220	97.1 ± 3.0 (88.5-105.0)	73.5 ± 2.6 (67.0-81.0)	30.7 ± 3.8 (24.5-43.0)	1.5 ± 1.1 (0-5)
Columbrets	595	96.9 ± 3.1 (89.0-105.5)	73.1 ± 2.6 (66.5-81.5)	29.3 ± 3.7 (22.3-41.2)	0.9 ± 0.8 (0-4)
Balearics (dry)	1,276	97.1 ± 3.5 (86.0-106.0)	73.3 ± 2.9 (65.0-81.5)	31.6 ± 4.3 (22.5-46.0)	1.5 ± 1.0 (0-6)
Balearics (wet)	15	101.3 ± 2.0 (98.0-104.0)	76.5 ± 1.7 (74.0-79.5)	37.1 ± 2.8 (33.3-44.3)	1.7 ± 0.8 (1-3)
Chafarinas	14		71.9 ± 2.1 (69.5-76.0)	28.2 ± 2.2 (22.7-31.1)	0.4 ± 0.9 (0-3)
N Morocco	10	94.9 ± 2.1 (91.5-98.5)	72.0 ± 1.9 (69.5-76.0)	30.6 ± 2.2 (28.1-33.7)	2.5 ± 1.1 (1-4)
S Morocco	52	94.5 ± 2.2 (89.5-98.0)	71.9 ± 2.0 (68.0-75.5)	26.1 ± 1.4 (23.6-30.4)	1.1 ± 0.5 (0-3)
Balearics (dry) *senator*	609	95.7 ± 2.9 (86.0-106.0)	72.3 ± 2.6 (65.0-81.5)	29.6 ± 3.2 (22.5-43.7)	1.5 ± 0.9 (0-5)
Balearics (dry) *badius*	274	100.2 ± 2.5 (87.0-106.0)	75.3 ± 2.1 (67.0-81.0)	35.8 ± 3.1 (24.0-46.0)	1.6 ± 1.0 (0-5)

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	-0.59 ± 0.89 (21)	-0.15 ± 0.66 (24)	0.21 ± 0.32 (112)	-0.64 ± 0.91 (2)		
Retraps >1 day	0.19 ± 0.30 (7)	-0.41 ± 0.50 (13)	0.01 ± 0.26 (51)			

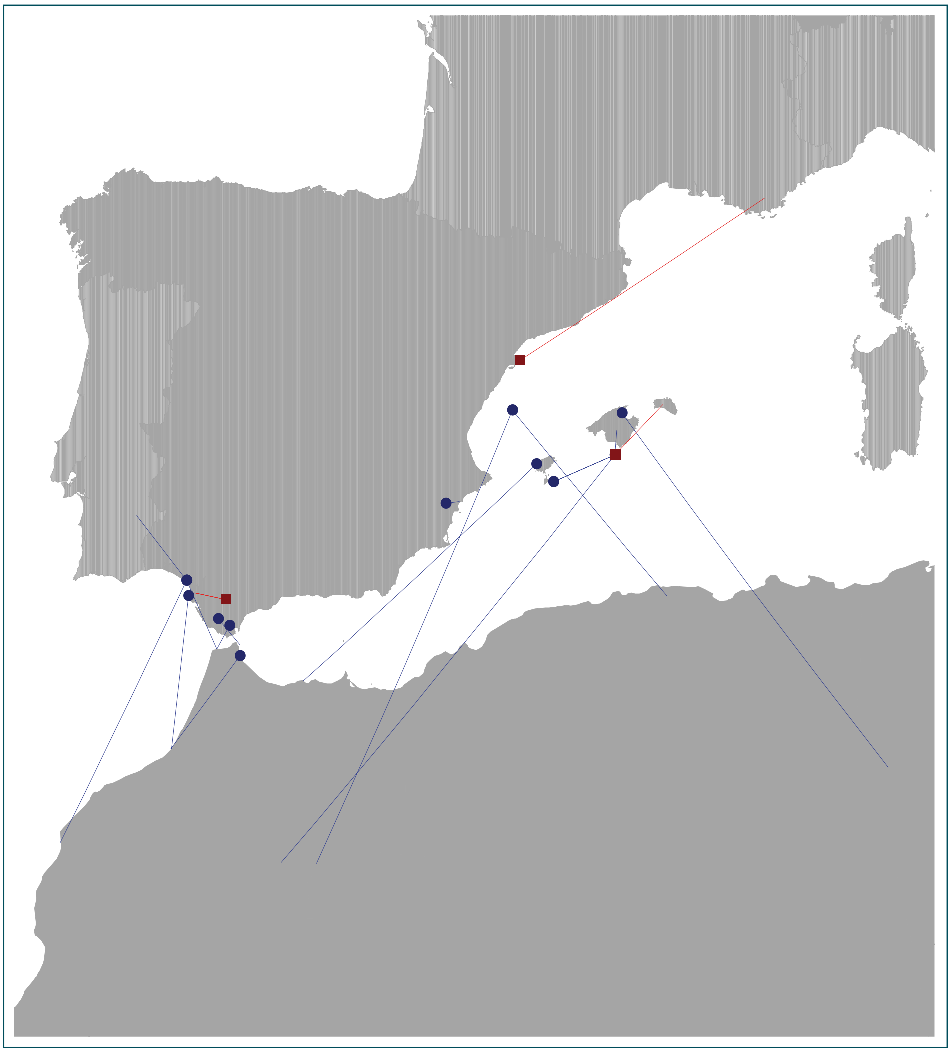


Figure 1. Map of recoveries of birds captured in the study area during the study period (March to May).

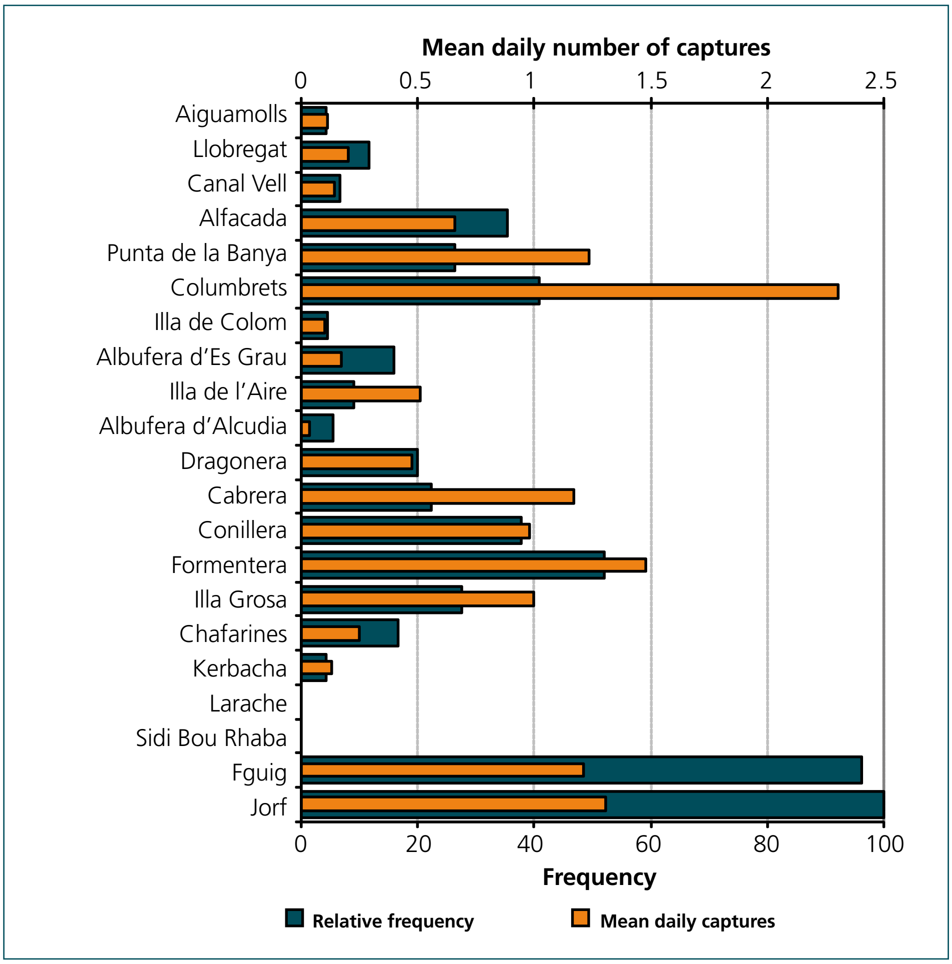


Figure 2. Relative frequency of captures and mean daily numbers according to site during the standard period (16 April to 15 May).

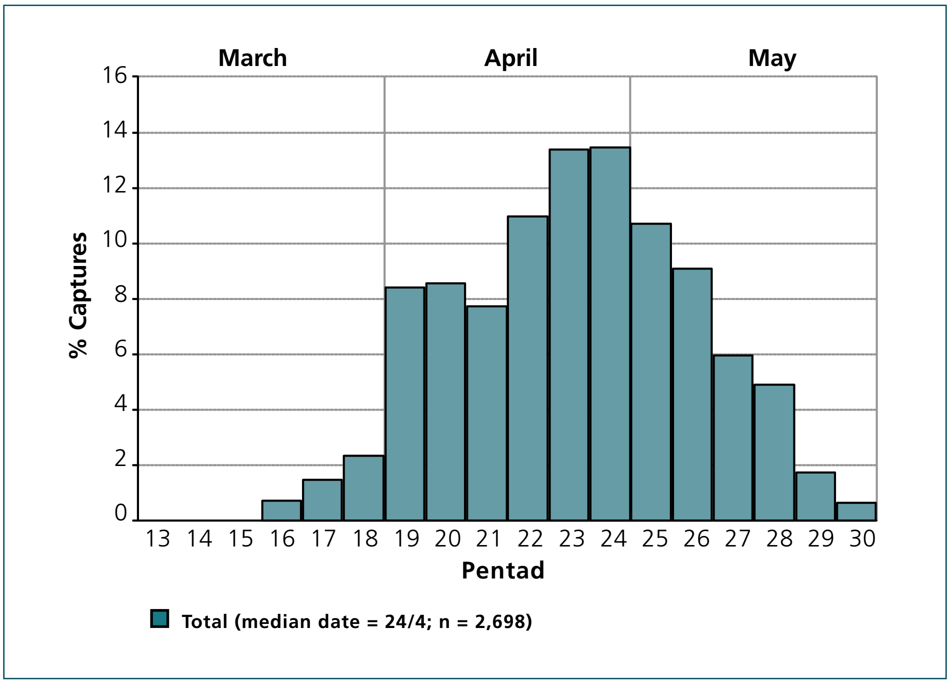


Figure 3. Frequency of captures during the study period.

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

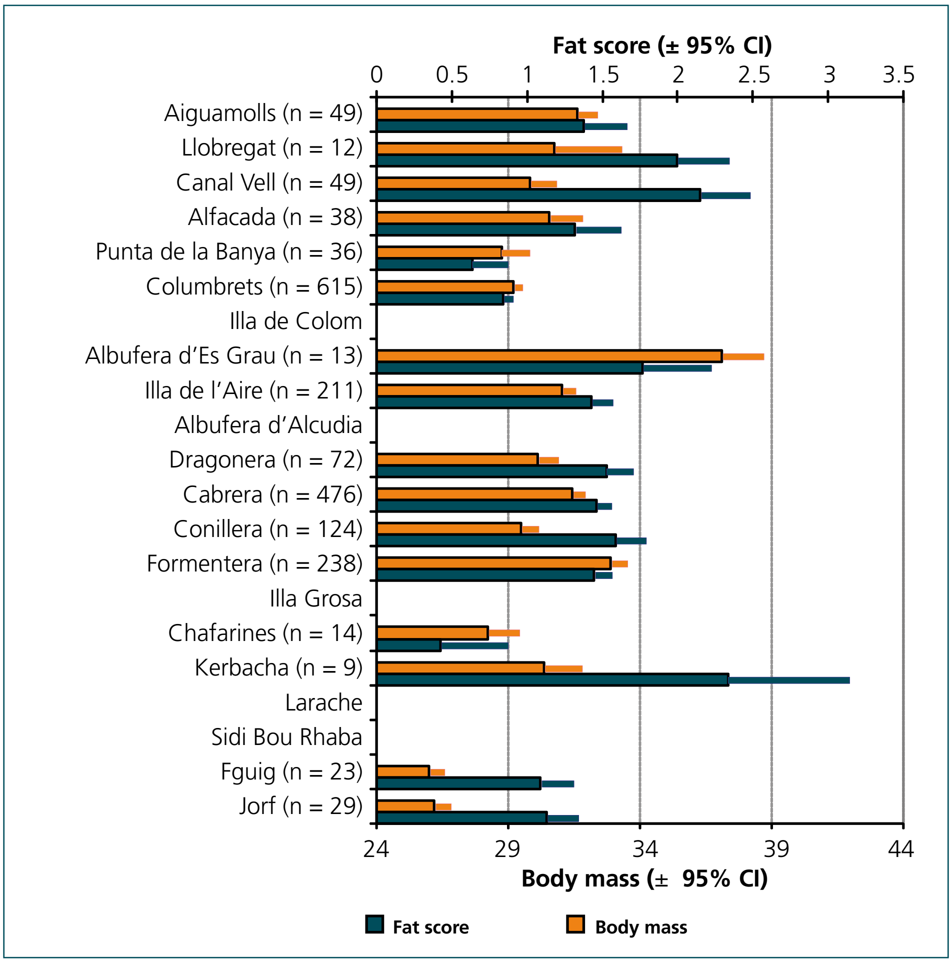
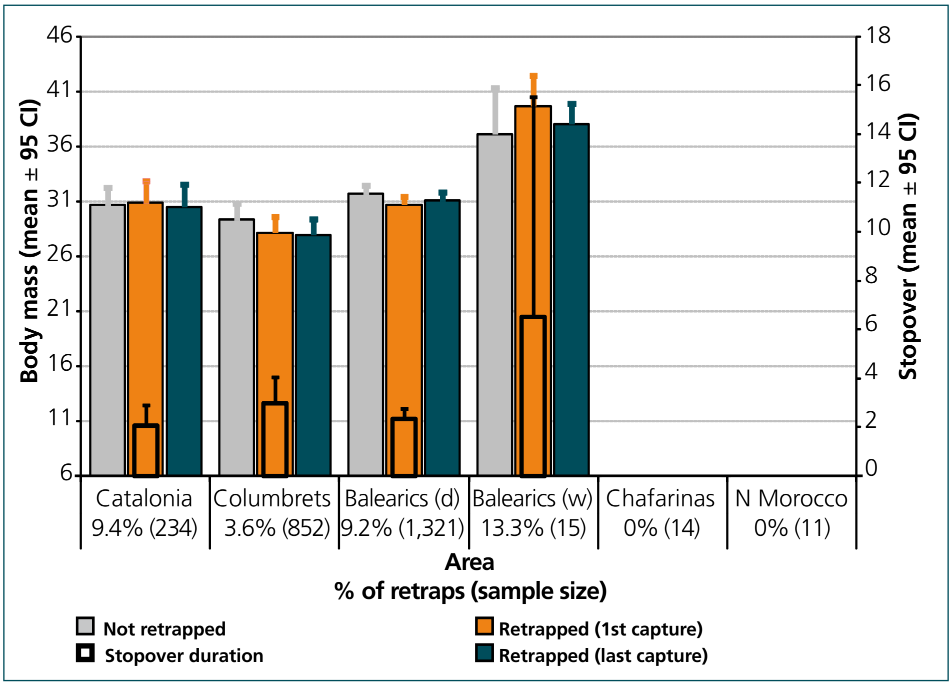


Figure 5. Variation in body mass by trapping status, minimum stopover length and frequency of retraps according to area.



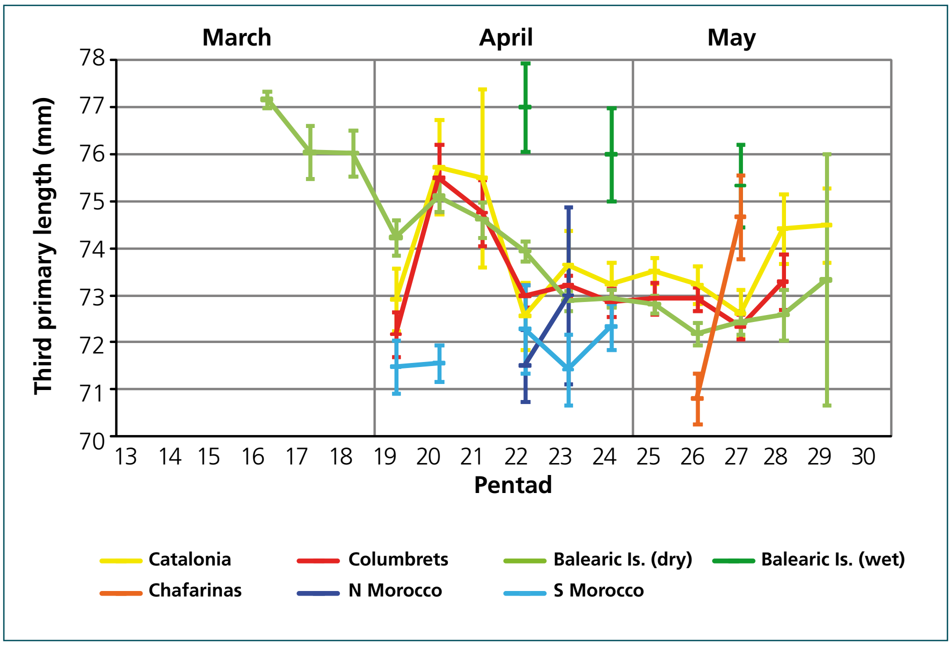


Figure 6. Temporal variation of third primary length according to area.

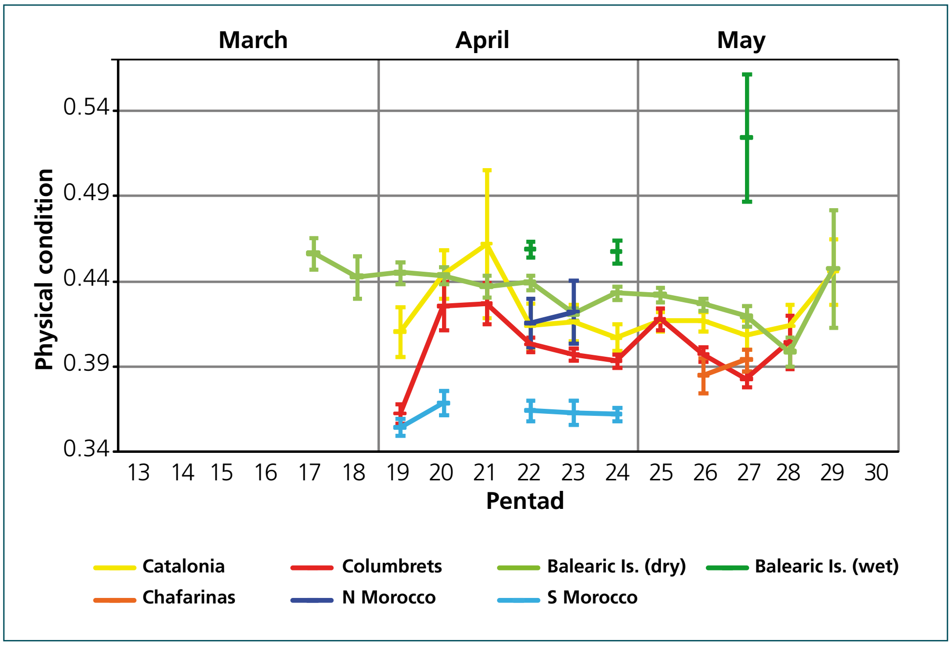


Figure 7. Temporal variation of physical condition according to area.

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

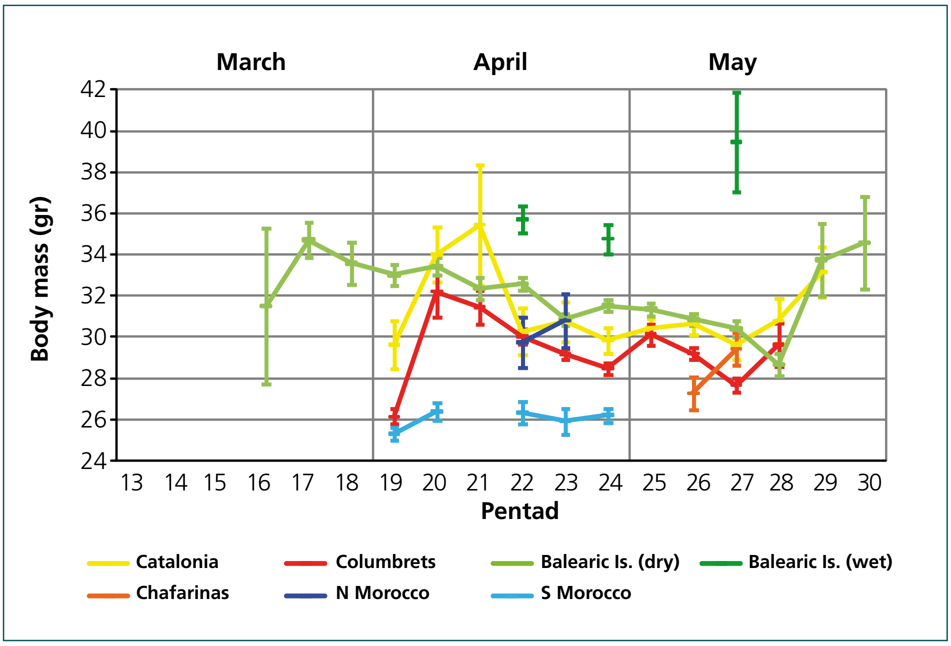
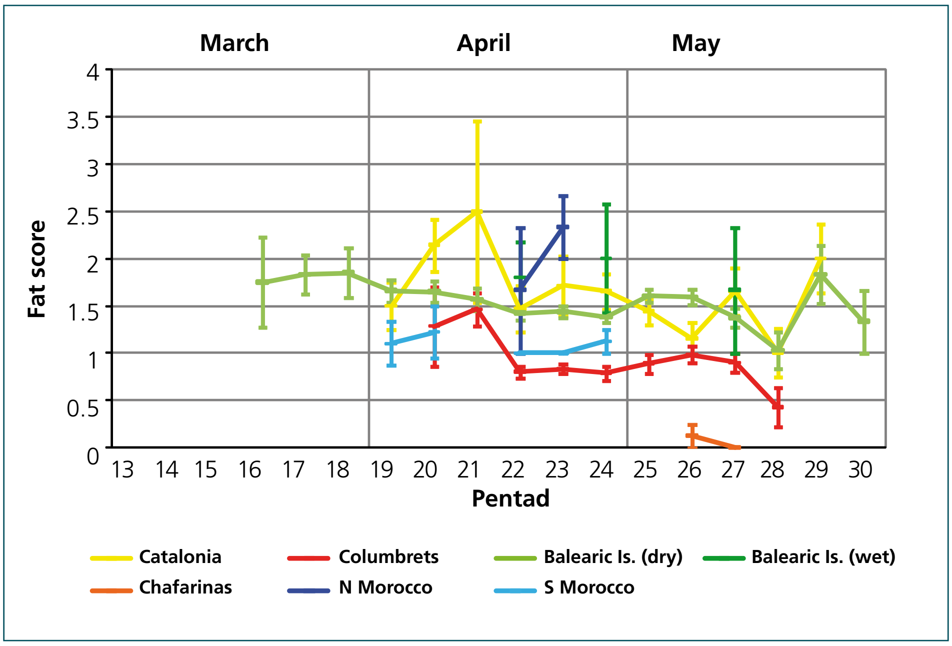


Figure 9. Temporal variation in fat score according to area.



Concluding remarks

The relevance of taking into account site-specific habitat and geographic characteristics

Wet *versus* dry Balearics

Of the 23 species for which enough data was available, in 18 (78%) mean body mass was significantly higher (in one nearly so) in the wet Balearics than in the dry Balearics (a similar result was obtained when analysing only data from common years; significant differences being found in 10 out of 13 species). These differences were generally paralleled by fat stores and physical condition and indicate that in general birds trapped in the wet Balearics were clearly in better average condition than those from the dry Balearics. Overall, average body mass across species was *c.* 7% lower in birds trapped in the dry Balearics, a relevant difference if we bear in mind, for example, that average body mass in the dry Balearics is only *c.* 4% lower than in Catalonia (table 1). In three species (Sedge and Garden Warblers and Pied Flycatcher) differences in body mass were also paralleled by differences in third primary and wing lengths, which in the wet Balearics were significantly longer in these three species than in the dry Balearics.

The present findings suggest that the dry Balearic sites attract birds that are on average in poorer body condition and thus are more likely to stop at the first opportunity. The fact that in some species the birds trapped in the dry Balearics had shorter wings also corroborates this view, since smaller size and/or shorter wings imply poorer flight capacity and higher susceptibility to adverse weather conditions (*cf.* Newton, 2008; Saino et al., 2010), which in turn lead to greater energetic stress levels. The frequency distribution of body mass, exemplified here by the Willow Warbler and the Common Swallow, indicates that the degree of variability is quite similar in both areas, although with on average lower values on dry islands (fig. 1). Thus, rather than a lack of captures of fat birds in less suitable stopover areas, the differences revealed here seem to reflect that the leaner is the bird the higher is its tendency to land at the first available site.

In contrast to the wet Balearics, the dry Balearic sites are located in smaller and more isolated islands and in more sparsely vegetated and less productive habitats. These sites, therefore, are not optimal for recovering from long flights and offer poor refuelling opportunities for forest and wetland species. Their lower suitability is further highlighted by the fact that in birds trapped here body mass at first capture tended to be clearly lower in birds retrapped on subsequent days than in those trapped only once (significantly so in 16 out of 29 species), an indication that birds that select to stay tend to be in poorer body condition and have less capacity to search for better areas. Moreover, those staying usually had negative fuel deposition rates (significantly so in 11 out of 29 species).

Given the great differences in habitat suitability between the dry and wet Balearics, it seems reasonable to assume that –whenever possible– birds will try to select the best stopover areas; it is well-known that migrants select with precision prior to or during landfall the habitats of their stopover sites (Chernetsov, 2006). In the Balearics (but apparently also elsewhere) this phenomenon is probably facilitated by the fact that landing seems to occur largely at dawn or shortly afterwards (Bruderer et al., 1996; Liechti et al., 1997; Chernetsov, 2006). Nevertheless, the question remains as to why better and not poorer body condition should lead to select for more suitable sites. Birds in poorer condition have greater need to refuel and thus may be more urged to select good quality stopover areas (for example, as found to occur in some desert oases by some authors [*e.g.* Biebach, 1990] but not by others [Salewski et al., 2010]). However, the poorer the physical state the higher may be the inclination to stop at the first available site, irrespective of its habitat suitability, or to put a limit to searching behaviour (*cf.* Yosef et al., 2006). For these birds, flying further in search of potentially better areas may be too risky or even impossible. A likely scenario in birds landing on the Balearics after sea-crossing.

In spite of being less suitable as a stopover site, the dry Balearics are often the first sites encountered by migrants and, correspondingly, act as attraction points for many birds (both of the wetlands studied here are located on the northern coast of two of the largest Balearics islands). The much higher capture indexes obtained in the dry Balearics compared to the wet Balearics testifies to this fact. On average capture indices are four times higher in dry than in wet sites, although, interestingly, this attraction effect not only occurs on somewhat isolated islands, but also on tiny islands that lie extremely close to the 'mainland' (a much larger island in this case). A typical case is that of L'Illa de l'Aire, a mere

Table 1. Differences (in %) in mean body mass between the four main study areas and the dry Balearics in birds trapped in spring. For samples and means, see Table 1 of the respective species accounts (differences are given only when at least five birds were measured in both areas).

Species	Wet Balearics	Els Columbrets	Catalonia	N Morocco
Streptopelia turtur	2.1	-2.7	-2.8	
Merops apiaster		20.3	2.6	-0.3
Upupa epops	-5.2	4.1	-4.9	
Riparia riparia	-5.7	7.9	-14.5	
Hirundo rustica	-7.9	9.3	-7.8	-15.5
Delichon urbicum	-11.7	7.6	-6.6	
Anthus trivialis	-6.3	5.0	-4.4	
Motacilla flava	-12.7	9.5	-7.0	
Erithacus rubecula	-6.8	4.9	-3.1	-12.2
Luscinia megarhynchos	-7.9	4.6	-2.8	-4.1
Phoenicurus phoenicurus	-7.5	3.4	-0.9	-5.0
Saxicola rubetra	-1.4	6.3	-0.6	-8.8
Turdus philomelos	-2.2	-2.4	-7.5	
Locustella naevia		-0.9	-7.2	-0.6
Acrocephalus schoenobaenus	-18.9	-4.2	-9.7	-5.0
Acrocephalus scirpaceus	-3.2	7.2	-3.6	2.4
Acrocephalus arundinaceus	-12.0	8.8	-5.6	-6.9
Hippolais icterina		9.7	-1.3	-10.7
Hippolais polyglotta		4.0	-4.2	-0.9
Sylvia cantillans	-2.7	2.3	-4.5	-11.0
Sylvia communis	-7.7	2.2	-3.4	-5.1
Sylvia borin	-8.3	4.9	-4.2	-7.4
Sylvia atricapilla	-3.2	2.3	0.4	-9.1
Phylloscopus bonelli		7.5	-1.7	-2.2
Phylloscopus sibilatrix	-5.7	10.0	-3.1	-7.5
Phylloscopus collybita	-6.3	1.4	-5.6	-7.8
Phylloscopus trochilus	-4.1	5.5	-0.7	-1.6
Muscicapa striata	-8.8	7.8	-5.5	-9.9
Ficedula hypoleuca	-6.1	8.1	-3.7	-6.0
Lanius senator	-14.7	8.1	3.1	3.3
Mean	-7.0	5.4	-4.0	-5.7
SD	4.5	4.8	3.6	4.8
n	25	30	30	23

1 km off the cost of Menorca. There, the mean daily number of captures is much greater than at S'Albufera d'Es Grau (13 times so in a forest species such as the Willow Warbler), a site which lies on Menorca just 17 km further north and with much better stopover options (as indicated by the results presented here and as would be expected in terms of habitat cover; *cf.* Kitirov et al., 2008). Moreover, as mentioned above, these small offshore islands not only attract birds in poor body condition. Therefore, these findings strongly suggest that in the Balearics the selection of stopover sites is often highly influenced by geographic and meteorological factors. Under this scenario, birds in a large range of physical conditions will end up landing at any given site, but poorer condition on average may lead to a greater probability of landing at the first available site, rather than to an increased inclination to search for a potentially better but more distant stopover site. Wetlands, moreover, are scarce in the Balearics and thus are often not just a short flight away.

The differences detailed here in average body mass between the wet and dry Balearics may also reflect differences in the refuelling options offered by both areas. Fuel deposition rates in wet Balearics tend to be more positive than in the dry Balearics and, accordingly, birds trapped there may include a higher proportion of birds that have already been at the site for a few days (or in the surrounding area) and that have recovered part of the energetic reserves lost during the long flight from N Africa. Moreover, at these sites, a greater proportion of dominant birds may also be present (e.g. males of some warblers that hold territories during migration; Cramp, 1992), which may also lead to an increase in the average condition and size of birds trapped there.

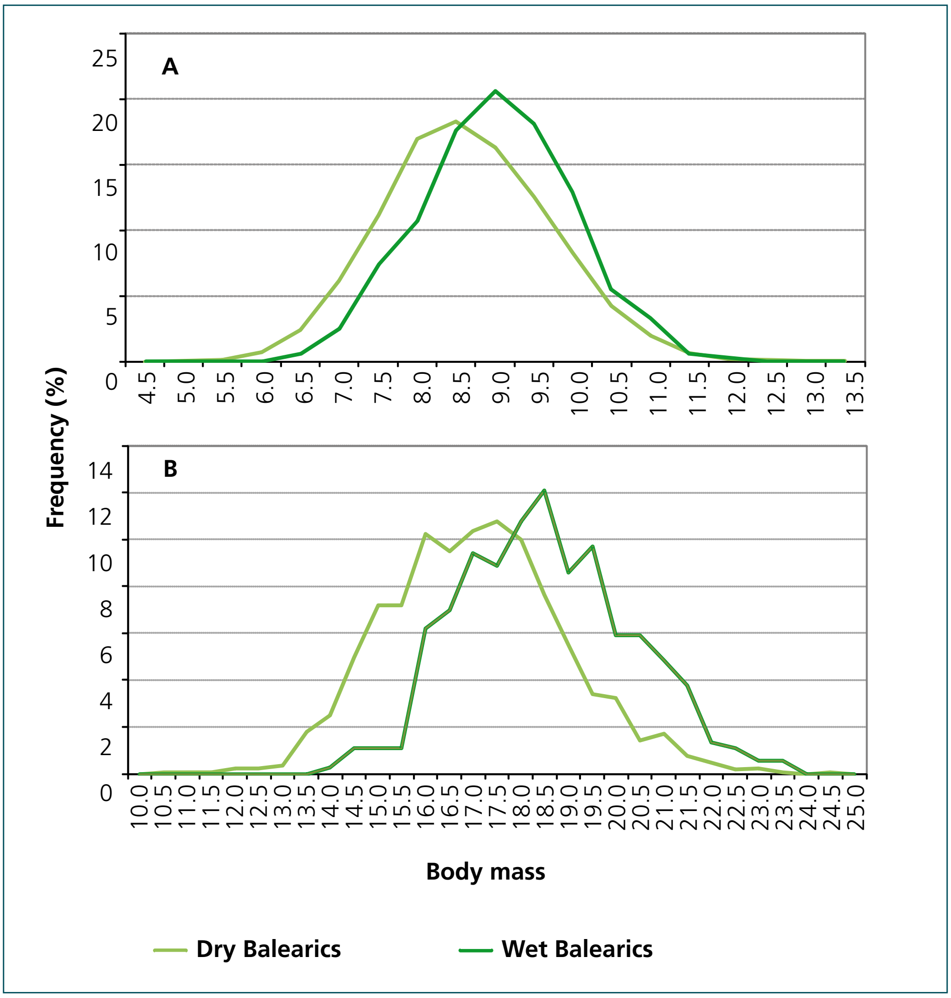


Figure 1. Frequency distribution of body mass in Willow Warbler (A) and Common Swallow (B) in the dry and wet Balearics.

Kerbacha *versus* Las Chafarinas

Differences between the dry and wet Balearics are in many ways paralleled by Las Chafarinas and Kerbacha. The islands of Las Chafarinas lie a mere 4 km off the north coast of Morocco and, in a contrast that resembles the differences between the dry and wet Balearics, are drier and much more sparsely vegetated than Kerbacha, a riverine site dominated by a tamarix forest. Out of 13 species for which enough data was available, in eight (62%) mean body mass was significantly lower in Las Chafarinas than in continental sites in N Morocco (above all Kerbacha). In the case of the Willow Warbler, birds from Las Chafarinas also had on average shorter third primaries. The interesting fact here is that Las Chafarinas lie to the north of the continent and so are not normally the first site that birds encounter during spring migration. It seems rather improbable that a higher proportion of birds in poorer physical condition ends up stopping in such a comparatively desolate area after overflying much better stopover sites just a few kilometres to the south. In fact, when confronted with an ecological barrier birds with lower fat reserves seem to be more likely to turn back in search of more suitable stopover sites rather than risk a sea-crossing (Bruderer & Liechti, 1998; Chernetsov, 2006).

In this case it would seem that the lower body mass and poorer condition of birds trapped on Las Chafarinas is a reflection of the relatively large number of birds that, having begun a sea-crossing, are forced to change or reverse flight direction due to unfavourable meteorological circumstances or energetic constraints. These birds would be expected to have on average lower fat reserves and body masses, because birds in poorer condition are likely to be more inclined to reverse movements and also because of the extra cost that a return flight supposes. Furthermore, the Willow Warblers trapped on these islands also had shorter average primaries since smaller or shorter-winged birds are more prone to suffer in unfavourable circumstances (*e.g.* particularly strong head winds; *cf.* Saino et al., 2010). Return movements from the sea in birds facing a large geographical barrier can represent 10–14% of all migrants (Bruderer & Liechti, 1998) and thus account also for a relevant proportion of the total birds trapped. In this case, Las Chafarinas would be the first available stopover site, which, together with the already well-known attraction effect, would mean that a higher proportion of these birds are trapped there than on nearby continental areas to the south.

Differences between continental and insular areas and between the islands of the W and C Mediterranean

Continent *versus* islands

The differences in body mass and refuelling options reported here between the dry and wet Balearics complicate the interpretation of the data from these islands. The two study sites in the wet Balearics are distinct because they are located on (1) large islands and (2) in wetlands, the latter a very scarce habitat in the Balearics. On the other hand, the data obtained in the dry Balearics comes from a much greater number of sites, some from small and somewhat isolated islands and islets, but others from sizeable islands such as Formentera. Moreover, although the range of habitats encountered in the dry Balearic sites are likewise not representative of the area as a whole, they are possibly more homologous - in terms of stopover suitability - to the Mediterranean forests, scrublands and dry arboreal croplands characteristic of most of the Balearics. All this suggests that the body mass of birds landing in most of the Balearics is closest to that reported herein from the dry Balearics sites. The fact that in many species average body mass in the wet Balearics was similar or even higher than in Catalonia would certainly seem to indicate that birds from this latter area represent a more exceptional subsample than those from the dry Balearics.

A comparison with data from N Africa also points in the same direction. Radar and infrared studies show that most birds take 5–8 hours to cross from N Africa to the southern coast of Mallorca (Bruderer, 2001), which, according to the average ground speed recorded in the area (48 km/s) and assuming a constant rate of mass loss of 1% (Delingat et al., 2008), implies a total mass loss of *c.* 5.5-9.1%. Since most birds migrating over the Balearics do not seem to stop before dawn (Liecthi et al., 1997), it could be assumed that many make non-stop flights of *c.* 9-10 hours, which would imply a somewhat greater reduction in mass of *c.* 10.4-11.7%. On average, body mass in the dry Balearics is *c.* 5.7% lower than in N Morocco (table 1). However, it should be taken into account that although the mean body mass recorded in these islands seems to be a good estimator of arrival mass (given the usually short stopover time and lack of mass gain recorded), the mean body mass recorded in N Morocco undoubtedly underestimates true departure body mass. Therefore, these considerations also suggest that data from the dry Balearics is more representative of the bulk of birds migrating through the Balearics in spring or, at least, to those stopping in the area. If most birds flying over the Balearics do not land there before dawn (see above), birds trapped on these islands will include a higher proportion of birds originating from further inland in N Africa than those passing through earlier during the night and, thus, have lower reserves (at the time they reach the islands) than those flying directly to continental Europe in long non-stop flights.

As a rule, mean body mass in the dry Balearics and Els Columbrets was lower than in Catalonia. Differences were significant in most species (27 out of 30), although in six cases only with respect to Els Columbrets. These differences certainly reflect the different refuelling conditions found in these two areas and the lower energetic demands made on birds flying over continental areas. As observed in many of the species studied here, birds migrating through continental Spain seem to move largely by means of short flight bouts and brief stopovers during which they usually gain some limited mass or at least maintain their fuel loads (in Catalonia positive significant fuel deposition rates were recorded in 10 species and negative rates in three out of 28 species analysed). However, birds passing through the Balearics and Els Columbrets are exposed to much more energetically demanding non-stop flights and, except those that take advantage of wetlands, have less opportunities to refuel successfully. Even in the dry Balearics, which offer better refuelling options than Els Columbrets, significant positive fuel deposition rates were only recorded in four species, while negative rates occurred in 11 cases (n = 29 species).

Differences between the Balearics and the Tyrrhenian islands

In most species, birds trapped in the dry Balearics tended to be in better condition than those from the Tyrrhenian islands. On average across species, in the dry Balearics body mass was 4.0% higher, although physical condition, which accounts for differences in size, was 5.9% better (table 2). These differences apparently reflect the different length of the stretches of open sea that birds have to cross to reach these areas (*c.* 230-320 km in the case of Balearics and *c.* 450-630 km in the Tyrrhenian islands). Moreover, birds migrating through these Italian islands also have to cross a longer, harsher part of the Saharan desert (Pilastro & Spina, 1997; Rubolini et al., 2002) and thus probably reach the north African coast more energetically stressed than their counterparts migrating further to the west.

The relevance of the distance from the north African coast is further underlined by the situation of Els Columbrets. This tiny archipelago is the most distant from N Africa (*c.* 375 km) of all our insular study sites and is also the most isolated. In 26 out of the 30 species studied, mean body mass was higher in the dry Balear-

Table 2. Comparison of mean body mass and physical condition between the Tyrrhenian islands and the dry Balearics in birds trapped in spring (differences shown as percentages). Values from the Tyrrhenian islands calculated from sample sizes and means given in Spina et al. (1993) and Pilastro & Spina (1997).

	Body mass			Physical condition		
Specie	Tyrrhenian islands	Dry Balearics	Difference (%)	Tyrrhenian islands	Dry Balearics	Difference (%)
Streptopelia turtur	122.6 (115)	128.8 (835)	5.1	0.691 (115)	0.743 (677)	7.5
Upupa epops	62.5 (246)	63.9 (447)	2.3	0.424 (246)	0.442 (378)	4.2
Hirundo rustica	16.7 (426)	17.1 (1740)	2.0	0.174 (426)	0.178 (1557)	2.3
Delichon urbicum	14.8 (134)	14.8 (228)	0.5	0.175 (134)	0.181 (192)	3.0
Anthus trivialis	18.0 (454)	20.7 (678)	15.0	0.265 (454)	0.309 (609)	16.5
Motacilla flava	13.9 (141)	15.9 (225)	14.0	0.226 (141)	0.263 (207)	16.4
Erithacus rubecula	14.5 (2390)	15.4 (6785)	6.2	0.269 (2390)	0.286 (6184)	6.0
Luscinia megarhynchos	19.2 (608)	19.5 (2122)	1.3	0.296 (608)	0.304 (1915)	2.8
Phoenicurus phoenicurus	13.2 (557)	14.1 (6309)	6.4	0.215 (557)	0.231 (5789)	7.3
Saxicola rubetra	14.4 (518)	16.0 (1940)	11.1	0.250 (518)	0.281 (1726)	12.5
Turdus philomelos	59.7 (355)	63.5 (394)	6.3	0.671 (355)	0.716 (379)	6.7
Locustella naevia	13.2 (23)	13.0 (297)	-1.6		0.266 (277)	
Acrocephalus schoenobaenus	10.7 (231)	10.6 (125)	-0.2	0.206 (231)	0.211 (118)	2.3
Acrocephalus scirpaceus	10.5 (44)	11.1 (733)	5.8	0.202 (44)	0.215 (664)	6.4
Acrocephalus arundinaceus	26.7 (61)	27.8 (74)	4.1	0.358 (61)	0.384 (59)	7.1
Hippolais icterina	12.0 (515)	12.6 (492)	5.7	0.195 (515)	0.207 (379)	6.1
Sylvia cantillans	9.2 (4011)	8.9 (2152)	-3.2	0.198 (4011)	0.195 (2036)	-1.4
Sylvia communis	13.3 (1431)	13.9 (6057)	4.4	0.239 (1431)	0.254 (5443)	6.5
Sylvia borin	15.7 (1627)	16.5 (5621)	4.9	0.255 (1627)	0.274 (5055)	7.4
Sylvia atricapilla	17.0 (896)	17.9 (4598)	5.3	0.307 (896)	0.318 (4381)	3.5
Phylloscopus bonelli	7.2 (28)	7.1 (738)	-0.8		0.148 (705)	
Phylloscopus sibilatrix	8.2 (1381)	8.9 (775)	9.0	0.139 (1381)	0.153 (646)	9.8
Phylloscopus collybita	7.0 (1010)	7.1 (3481)	1.4	0.159 (1010)	0.161 (3319)	1.4
Phylloscopus trochilus	8.2 (2475)	8.6 (28547)	5.9	0.160 (2475)	0.169 (26951)	5.6
Muscicapa striata	13.4 (355)	13.0 (3296)	-2.9	0.197 (355)	0.201 (2987)	2.0
Ficedula hypoleuca	10.8 (1172)	11.5 (4883)	5.9	0.176 (1172)	0.189 (4356)	7.4
Lanius senator	33.2 (336)	31.6 (1417)	-4.8	0.438 (336)	0.432 (1276)	-1.5
Mean			4.0			5.9
SD			4.8			4.5
n			27			25

ics than in Els Columbrets by on average c. 5.4% (table 1). A difference that is only slightly lower than that observed in comparison with the Tyrrhenian islands.

Crossing the W Mediterranean Sea in spring

Are birds more likely to cross over open sea in spring than in autumn?

In many species differences in the routes followed to cross the W Mediterranean Sea in autumn and spring are known to occur. In autumn movements in a southwesterly direction predominate in Europe and birds concentrate in C and W Iberia before they reach or overfly NW Africa; in spring, however, birds return along a more direct easterly (or central) route that leaves most of W Iberia devoid of birds, but increases the numbers passing through the Balearics (Alerstam, 1990; Cramp, 1992; Bruderer & Liechti, 1999; Telleria et al., 1999; Newton, 2008). We have observed this 'loop migration' pattern in 17 of the 28 species studied, in four cases further corroborated by recoveries. In the western Sahara birds also concentrate further westwards in autumn, but return on a broader and more direct front in spring (Trösch et al., 2005). In the only two species studied that largely move towards SE Europe in autumn, Icterine and Wood Warblers, a different but equivalent shift in their preferred routes has also been found, again in agreement with previous results (Zink, 1973; Cramp, 1992) and indicating that birds return in spring along a more westerly but more direct route than in autumn.

These differences in the main routes followed in autumn and spring indicate that a greater proportion of long-distance migrants passing through the W Mediterranean move directly across the sea in spring than in autumn. The large numbers of captures in spring on Mediterranean islands (Spina et al., 1993; Spina & Volponi, 2008, 2009; present work) provide a clear indication of this phenomenon; in addition, trans-Saharan migrants are comparatively less common in autumn than in spring in the Balearics (GOB, unpubl.). In fact, in the present work we have only detected a clear tendency to avoid passing through the Balearics in a few species, mostly those linked to wetlands (*e.g.* Reed and Great Reed Warblers), which may find it particularly difficult to find suitable stopover sites on these islands, and in the Melodious Warbler, a species known to circumvent the Mediterranean through continental Spain and S France (Pilastro et al., 1998). The situation is different in short-distance migrants, since many winter in NW Africa and therefore cross the Mediterranean in large numbers in both spring and autumn (Bruderer & Liechti, 1999; GOB, unpubl.).

The selection of a shorter, more direct route can also reduce the total duration of the migration and thus guarantee the earlier arrival on breeding grounds sought by many birds in spring (Alerstam, 1990; Newton, 2008). In fact, several sources indicate that migration in spring takes place at a faster rate than in autumn (Fransson, 1995; Newton, 2008). However, despite the need to shorten the route may also have played a role, loop migration patterns seem to have been largely modelled by seasonal differences in prevailing winds and other biogeographical factors (Newton, 2008).

Unusual movements and their links with meteorological conditions

In spite of these general differences found between autumn and spring migration routes, the exact routes followed by birds crossing the Mediterranean seem to be subject to a large degree of variability. A total of 18 recoveries of eight species detailed here (10 for Willow Warblers) suggest that marked differences exist from one year to another in the specific routes followed by individual birds. Most of the cases (14) refer to birds trapped in NE Spain and the Balearics in one spring and in Italy or Tunisia in another, which would indicate that birds cross the Mediterranean at longitudinally very distant sites in different years (up to *c.* 1,500 km apart). The meteorological conditions encountered by birds while attempting to cross the Mediterranean may explain such variability. Birds that have to face unfavourable weather conditions, above all storms and adverse winds, while flying over continental areas can always land; however, this is often impossible while crossing large expanses of open sea. In the event of strong head- or cross-winds, birds flying over the sea may prefer to be drifted longitudinally for large distances or even southwards rather than try to continue into the wind and risk running out of fuel whilst over the sea (Alerstam, 1990; Newton, 2008). Although to a lesser extent, this drift can also occur while crossing the Sahara since suitable stopover areas are much scarcer than in mainland NW Africa or Europe.

The effects of weather on birds crossing the Mediterranean are further exemplified by the reverse movements revealed by the recoveries of four species (Subalpine Warbler [3 birds], Spotted Flycatcher [2], Nightingale [1] and Melodious Warbler [1]). The majority of these recoveries seem to reflect return flights of migrants that had overshot their breeding sites. In most cases, in such movements taking place within the Balearics/Els Columbrets the distance flown back is relatively short (130-260 km), although in a few cases (Nightingale and Melodious Warbler) these distances can reach nearly 1,000 km. Six out of the seven birds showing this type of movement were first trapped to the east of their presumed breeding grounds, a further indication that birds were probably blown there by dominant westerly winds (*cf.* Barriocanal, 2007).

The number of reverse movements detailed here between the islands contrasts with the scarcity of recoveries in the opposite direction which, at first glance, would be expected to occur in greater number given the overall northward component in movements of spring migrants. In fact, we only report one case here, that of a Woodchat Shrike breeding on Menorca and captured on Cabrera 39 days beforehand. This all but total lack of northward recoveries within the Balearics/Els Columbrets reflects the fact that the vast majority of birds that continue northwards from these islands do so via long-distance flights that will take them directly to continental NE Spain or France (*cf.* Bruderer et al., 1996; Liechti et al., 1997).

Do birds migrating across the sea move in a more northerly direction than those crossing nearby continental areas?

In six out of 13 species with available data, recoveries from the Balearics/Els Columbrets seem to show more direct due northerly flight directions and less of an E European origin than in birds trapped in Catalonia. In some cases (*e.g.* Reed Warbler and even Blackcap) this pattern is fairly obvious and, despite the generally small sample sizes and some uncertainty on the real destination or origin of birds (see the Methodological introduction for more details), would seem to be genuine. Radar studies in the Balearics have also shown that birds crossing the Mediterranean Sea move in a more due northerly direction than in nearby European continental areas, *e.g.* S France, where NNE or NE movements are the rule (Bruderer et al., 1996; Speich, 1999). If birds cross the Mediterranean along a more direct due northerly direction instead of heading NNE or NE, they can substantially reduce the distance that they have to cover over open water (Bruderer et al., 1996) and thus reduce the risks inherent in such flights.

Above all in species such as the Reed Warbler, which seems to avoid long sea-crossings, the more due northerly average flight direction observed on the islands may

Table 3. Fuel deposition rate (as % of lean body mass per day) and minimum stop-over length in six species trapped in N Morocco in spring. Only species with significant refuelling rates are shown. Lean body mass calculated as average body mass of birds with a 0 fat score (all study areas). Means ± 95% confidence intervals and sample sizes are given.

Species	Fuel deposition rate	Minimum stop-over length	Lean body mass
Luscinia megarhynchos	1.67 ± 0.97 (39)	4.93 ± 1.22 (54)	17.80 ± 0.17 (614)
Acrocephalus schoenobaenus	2.54 ± 2.00 (5)	7.00 ± 3.51 (5)	9.41 ± 0.28 (46)
Acrocephalus scirpaceus	1.36 ± 0.57 (104)	5.89 ± 0.93 (143)	10.14 ± 0.09 (395)
Acrocephalus arundinaceus	2.54 ± 1.95 (6)	4.30 ± 1.46 (10)	27.49 ± 0.82 (67)
Sylvia borin	3.01 ± 2.20 (12)	2.31 ± 0.85 (26)	14.71 ± 0.09 (805)
Phylloscopus trochilus	2.60 ± 1.48 (34)	3.24 ± 0.76 (49)	8.12 ± 0.11 (226)

reflect the fact that a large number of birds crossing the Mediterranean are following a more direct route, perhaps because they have been delayed and need to make up time (*cf.* Barriocanal & Robson, 2006). The comparatively higher number of recoveries of birds apparently originating in the British Isles that pass through the Balearics/Els Columbrets (*e.g.* Blackcap, Sedge Warbler, Redstart) may also reflect a greater presence in these islands of birds undertaking more direct return movements.

Drifting is a final but probably rather significant factor that may also help to explain these differences in flight directions between insular and continental areas. As described above for birds making reverse movements, eastward rather than westward drift would seem to be the most common situation given the prevailing westerly winds in the W Mediterranean. Accordingly it would be expected that many more birds end up being captured in the Balearics/Els Columbrets after drifting from the west than from the east, both due to the prevailing winds and the fact that more birds pass to the west than to the east of these islands (the spring passage of birds between N Morocco and SE Spain may be more than three times greater than in the open sea east of the Balearics; Liechti et al., 1997; Bruderer & Liechti, 1999). Once these birds redetermine their migratory direction to compensate for wind displacement (*cf.* Moore, 1990), their subsequent movements may end up artificially increasing the northerly and even NNW component of recoveries from the islands.

The role of NW Africa during spring migration

In 10 out of the 11 species analysed in N Morocco fuel deposition rates were positive and in six cases significantly so (birds retrapped the day after first capture were excluded to avoid possible handling effects; Schaub & Jenni, 2000; Schwilch & Jenni, 2001). Of those species with significant refuelling rates, daily deposition represented 1.4-3.0% of lean body mass (mean 2.3%), which, taking into account average minimum stopover lengths, gives average mass gains of *c.* 10.1% of lean body mass (table 3).

Sample sizes of retraps were usually small and limited to a few species, however, the comparison of mean body mass in S and N Morocco indicates that mass gain in NW Africa is rather generalized in the studied species (table 4). Across species, the average body mass recorded in northern coastal areas of NW Africa (Morocco and Tunisia) were 12.2% higher than that obtained in SE Morocco (11.6% higher if data from Tunisia are excluded). However, as mentioned above, mean body mass recorded in N Morocco undoubtedly underestimates true departure body mass, particularly in birds that have to undertake long non-stop flights over the Mediterranean. In this respect, it should be noted that birds flying directly from N Africa to S France or NE Spain would require a minimum initial fuel load of *c.* 13%-18% (assuming a sea-crossing of *c.* 600 km, take-off areas up to 200 km inland from the N African coast, ground speed of 48 km/h and a constant rate of mass loss of 1%; Speich, 1999; Bruderer, 2001; Delingat et al., 2008).

As observed in the Balearics, body mass in different areas of SE Morocco may also vary according to habitat (or oasis size), although for the time being the pattern remains unclear and requires further study. In fact, some studies in the Sahara have found that mean body mass in migrants trapped in large oases is higher than in those captured in small ones or in very sparsely vegetated areas (Salewski et al., 2010), whilst others suggest the opposite (Biebach et al. 1986, Bairlein 1992). In Jorf and Figuig several species (*e.g.* Willow Warbler, Common Swallow) had higher mean body masses than in the much smaller oases of Defilia and Merzouga, although the possibility that this responds to inter-annual variations rather than habitat-specific conditions cannot be ruled out since datasets were collected in different years and sample sizes were somewhat limited. In fact, data collected at Jorf in 2005 (Maggini & Bairlein, 2011) show distinctly lower means than those reported here for 2006 at the same site and very similar figures to those from Defilia and Merzouga. On the other hand, in species such as Blackcap and Chiffchaff differences in body mass between different oases largely seem to reflect the fact that in these species the ratio of the number of wintering versus trans-Saharan migrants is higher in large oases. We consider, therefore, that in general terms the overall means detailed here for SE Morocco are rather

Table 4. Comparison of mean body mass between SE Morocco and N Morocco and N Tunisia in all species with available data from spring. Means and sample sizes (in brackets) are given. Values calculated using present data and all other available information for both areas (Ash, 1969; Smith, 1979; Cramp, 1992; Grattarola et al., 1999; Waldenström et al., 2004; Gargallo et al., unpubl.; see species accounts for further details).

Species	SE Morocco	N Morocco & N Tunisia	Difference (%)
Merops apiaster	51.4 (66)	55.8 (16)	8.5
Riparia riparia	11.3 (269)	13.3 (9)	17.8
Hirundo rustica	16.3 (2661)	19.0 (247)	16.8
Delichon urbicum	14.6 (281)	17.3 (6)	18.7
Anthus trivialis	18.5 (70)	23.5 (10)	26.8
Luscinia megarhynchos	19.4 (688)	20.5 (369)	5.7
Phoenicurus phoenicurus	13.0 (244)	14.9 (73)	14.7
Saxicola rubetra	14.0 (39)	17.1 (10)	22.5
Locustella naevia	11.7 (19)	13.1 (13)	11.8
Acrocephalus schoenobaenus	9.9 (161)	10.8 (144)	9.4
Acrocephalus scirpaceus	10.2 (414)	10.8 (1214)	6.4
Acrocephalus arundinaceus	27.1 (24)	29.7 (93)	9.6
Hippolais icterina	11.4 (9)	13.6 (31)	19.7
Hippolais polyglotta	10.2 (51)	10.7 (191)	4.1
Sylvia cantillans	9.0 (406)	9.8 (158)	9.0
Sylvia communis	13.8 (124)	15.3 (106)	10.5
Sylvia borin	17.1 (167)	18.0 (698)	5.5
Sylvia atricapilla	14.3 (246)	19.5 (361)	36.3
Phylloscopus bonelli	7.2 (244)	7.3 (11)	1.5
Phylloscopus sibilatrix	8.6 (84)	9.5 (101)	10.4
Phylloscopus collybita	7.0 (138)	7.5 (127)	6.1
Phylloscopus trochilus	8.2 (633)	8.7 (702)	6.8
Muscicapa striata	13.2 (37)	14.4 (66)	9.0
Ficedula hypoleuca	11.8 (249)	12.2 (179)	3.4
Lanius senator	28.1 (212)	32.4 (35)	15.2
Mean			12.2
SD			8.08
n			25

Table 5. Comparison between maximum body mass recorded in the Sahel in spring and mean body mass of birds trapped in SE Morocco. Means and sample sizes (in brackets) are given for SE Morocco (Ash, 1969; Gargallo et al., unpubl.; present data).

Species	Sahel	SE Morocco	Difference (%)	Reference
Anthus trivialis	36.5	18.5 (70)	-49.2	Smith (1966)
Motacilla flava	26.0	15.1 (297)	-41.9	Wood (1992)
Saxicola rubetra	26.0	14.0 (39)	-46.2	Smith (1966)
Locustella naevia	20.0	11.7 (19)	-41.5	Bayly et al. (in prep)
Acrocephalus schoenobaenus	19.5	9.9 (161)	-49.3	Fry et al. (1970)
Sylvia cantillans	16.5	9.0 (406)	-45.6	Ottoson et al. (2001)
Sylvia communis	29.5	13.8 (124)	-53.1	Ottoson et al. (2001)
Sylvia borin	32.5	17.1 (167)	-47.4	Smith (1966)
Sylvia atricapilla	30.0	14.3 (246)	-52.2	Ottoson et al. (2001)
Muscicapa striata	22.5	13.2 (37)	-41.3	Smith (1966)
Ficedula hypoleuca	22.0	11.8 (249)	-46.2	Smith (1966)
Mean			-46.7	
SD			4.1	
n			11	

representative of the bulk of the birds arriving in the area in spring. In any case, since data from N Morocco certainly underestimates real mean take-off mass of the area, the differences in body mass given here between S and N Morocco are probably fairly conservative.

Data from SE Morocco comes from sites located *c.* 1,500 km north of the Sahel. Following the approach of Salewski et al. (2010), and taking into account the average ground speed recorded in spring migrants in the Sahara (59 km/h) and a constant rate of mass loss of 1% (Delingat et al., 2008), birds covering this distance would lose *c.* 22% of their total take-off body mass if they used a non-stop migration strategy; but they would lose *c.* 33% in the more likely case (*cf.* Schmaljohann et al., 2007a, 2007b) that they undertake an intermittent strategy without refuelling en route. On average, mean body mass in 11 species captured in SE Morocco is 47% lower than the highest values recorded in the Sahel in spring (table 5), suggesting that an average total mass loss of *c.* 30-40% could be rather realistic. This figure indicates that, averaging across species, refuelling in NW Africa re-establishes approximately a minimum of *c.* 18-28% of the energetic reserves lost after crossing the Sahara, a gain that can be particularly relevant in birds that still have to cross the Mediterranean on a long non-stop flight.

This finding agrees with the suggestion that after winter rains NW Africa plays a relevant refuelling role for many birds (Moreau, 1961; Alerstam, 1990; Wood, 1992). In this respect, radar studies also have shown that the vast majority of birds migrating through the Mediterranean rest in coastal and adjacent inland areas of NW Africa (up to *c.* 250 km inland) and that, at least in passerines, the number of birds that fly non-stop across both the Sahara and the Mediterranean Sea is statistically irrelevant (Bruderer & Lieachti, 1999; Speich, 1999; Bruderer, 2001). The relevance of NW Africa in spring is also further corroborated by the fact that in many of the species studied here migrants (and often also recoveries) are more common in NW Africa in spring than in autumn (Zink, 1973; Alerstam, 1990; Cramp, 1992; present results).

Some studies based on birds trapped in the Tyrrhenian islands (Pilastro & Spina, 1997) have been interpreted as indirect evidence of a lack of substantial fattening up in NW Africa (Grattarola et al., 1999). However, the existence of refuelling in NW Africa and the key finding of these analyses, *i.e.* that the distribution of preferred habitats just south of the Sahara is the main factor constraining spring migration, are not necessarily contradictory.

References

Alerstam, T., 1990. *Bird Migration*. Cambridge University Press, England.

Alerstam, T. & Enckell, P. H., 1979. Unpredictable habitats and evolution of bird migration. *Oikos*, 33: 228-232.

Andriaensen, F. & Dhondt, A. A., 1990. Population dynamics and partial migration of the European robin (Erithacus rubecula) in different habitats. *Journal of Animal Ecology*, 59: 1077-1090.

Ash, J. S., 1969. Spring weights of trans-Saharan migrants in Morocco. *Ibis*, 111(1): 1-10.

Aymí, R. & Martínez, I., 1990. Presència i situació d'algunes subespecies d'ocells a Catalunya. *Butlletí del Grup Català d'Anellament*, 7: 45-52.

Bacetti, N., Massa, B. & Violani, C., 2007. Proposed synonymy of *Sylvia cantillans moltonii* Orlando, 1937, with *Sylvia cantillans subalpina* Temminck, 1820. *Bulletin of the British Ornithologists' Club*, 127: 107-110.

Baggot, G. K., 1986. The fat contents and flight ranges of four warbler species on migration in North Wales. *Ringing & Migration*, 7: 25-36.

Bairlein, F., 1991. Body mass of Garden Warblers (*Sylvia borin*) on migration: a review of field data. *Vogelwarte*, 36:48–61.

Bairlein, F., 1992. Recent prospects on trans-Saharan migration of songbirds. *Ibis*, 134(1): 41-46.

Bairlein, F., 1995. *Manual of field methods. European–African songbird migration network*. Revised edition. Wilhelmshaven, Germany.

Bairlein, F., Alström, P., Aymí, R., Clement, P., Dyrcz, A., Gargallo, G., Hawkins, F., Madge, S., Pearson, D. & Svensson, L., 2006. Family Sylviidae (Old World Warblers). In: *Handbook of the Birds of the World*, vol. 11. *Old World Flycatchers to Old World Warblers*: 492-709 (J. del Hoyo, A. Elliott & D. A., Christie, Eds.). Lynx Edicions, Barcelona.

Bayly, N. J. & Rumsey, S. J. R., 2007. Grasshopper Warbler *Locustella naevia* autumn migration – findings from a study in southeast Britain. *Ringing & Migration*, 23: 147-155.

Bayly, N. J. & Rumsey, S. J. R., 2010. Garden Warbler *Sylvia borin* migration in sub-Saharan west Africa. *Ringing & Migration*, 25: 59-61.

Bayly, N. J., Rumsey, S. J. R. & Clark, J. A., 2011. Crossing the Sahara Desert – Migratory Strategies of the Grasshopper Warbler Locustella naevia. *Journal of Ornithology*, 152: 933-946.

Balmori, A., 2003. Tórtola europea, Streptopelia turtur. In: *Atlas de las aves reproductoras de España*: 306-307 (R. Martí & J. C. del Moral, Eds.). Dirección General de Conservación de la Naturaleza – Sociedad Española de Ornitología, Madrid.

Barriocanal, C., 2007. Influència del vent en la migració dels ocells a la primavera:el cas de l'illa de l'Aira (Sant Lluís. Menorca). Informe inèdit, Institut Menorquí d'Estudis.

Barriocanal, C. & Robson, D., 2006. Late arrivals on islands of some spring migrating passerines in the western Mediterranean. *Ardeola*, 53(2): 333-340.

Barriocanal, C. & Robson, D., 2007. Spring passage of Willow Warbler *Phylloscopus trochilus* across the western Mediterranean: comparing islands with the mainland. *Ardea*, 95(1): 91-96.

Battley, P. F., Piersma, T., Dietz, M. W., Tang, S., Dekinga, A. & Hulsman, K., 2000. Empirical evidence for differential organ reductions during trans-oceanic bird flight. *Proceedings of the Royal Society B*, 267: 191-195.

Bermejo, A., & De la Puente, J., 2002. Stopover characteristics of Sedge warbler *Acrocephalus schoenobaenus* in central Iberia. *Die Vogelwarte*, 41: 181-189.

Bermejo, A. & De la Puente, J., 2003. Zarzero Común (*Hippolais polyglotta*). In: *Atlas de las aves reproductoras de España*: 466-467 (R. Martí & J. C. del Moral, Eds.). Dirección General de Conservación de la Naturaleza – Sociedad Española de Ornitología, Madrid.

Bermejo, A., De la Puente, J. & Pinilla, J., 2002. Fenología, biometría y parámetros demográficos del Zarcero Común (*Hippolais polyglotta*) en España central. *Ardeola*, 49: 75-86.

Bernis, F., 1962. Sobre migración de nuestros Passeriformes transaharianos. *Ardeola*, 8: 41-119.

Bernis, F., 1971. *Aves Migradoras Ibéricas*, fascs. 7.° y 8.°: Aláudidos a Prunélidos. SEO, Madrid.

Berthold, P., 1973. Proposals for the standardisation of the presentation of data of animal events, especially migratory data. *Auspicium*, Suppl.: 49–57.

Berthold, P., 1996. *Control of bird migration*. Chapman and Hall, London.

Berthold, P., Fliege, G., Heine, G., Quemer, U. & Schlenker, R., 1991. Wegzug, Rastverhalten, Biometrie, und Mauser von Kleinvögeln in Mitteleuropa. *Vogelwarte*, 36: 1-221.

Berthold, P., Querner, U. & Schlenker, R., 1990. *Die Mönchsgrasmücke* Sylvia atricapilla. Die Neue Brehm-Bücherei. A. Ziemscn Verlag, Wittenberg Lutherstadt.

Biebach, H., 1990. Strategies of trans-Sahara migrants. In: *Bird migration. Physiology and ecophysiology*: 352-367 (E. Gwinner, Ed.). Springer, Berlin Heidelberg New York.

Biebach, H., Biebach, I., Friedrich, W., Heine, G., Partecke, J. & Schmidl, D., 2000. Strategies of passerine migration across the Mediterranenan Sea and the Sahara desert: a radar study. *Ibis*, 142: 623-634.

Biebach, H., Friedrich, H. & Heine, G., 1986. Interaction of bodymass, fat, foraging and stopover period in trans-Sahara migrating passerine birds. *Oecologia*, 69: 370-379.

BirdLife International, 2004. *Birds in Europe: population estimates, trends and conservation status*. Birdlife International, Cambridge.

Blondel, J., 1967. Etude d'un cline chez le rouge-queue à front blanc *Phoenicurus phoenicurus* L. La variation de la longueur de l'aile, son utilisation dans l'étude des migrations. *Alauda*, 35(2): 83-193.

Blondel, J. & Isenmann, P., 1981. *Guide des Oiseaux de Camargue*. Delachaux et Niestlé, Neuchatel.

Bolshakov, C. V., Bulyuk, V. N., Mukhin, A. & Chernetsov, N., 2003a. Body mass and fat reserves of Sedge Warblers during vernal nocturnal migration: departure versus arrival. *Journal of Field Ornithology*, 74: 81-89.

Bolshakov, C. V., Bulyuk, V. N. & Chernetsov, N., 2003b. Spring nocturnal migration of Reed Warblers *Acrocephalus scirpaceus*: departure, landing and body condition. *Ibis*, 145: 106-112.

Bønløkke, J., Madsen, J., Thorup, K., Pedersen, K. T., Bjerrum, M. & Rahbek, C., 2006. *The Danish Bird Migration Atlas*. Forlaget Rhodos A/S & Zoologisk Museum, København.

Both, C. & Marvelde, L. T., 2007. Climate change and timing of avian breeding and migration throughout Europe. *Climate Research*, 35: 93-105.

Both, C. & Visser, M. E., 2001. Adjustement to climate changes is constrained by arrival date in a long-distance migrant bird. *Nature*, 411: 296-298.

Brambilla, M., Tellini, G., Sorace, A. & Guidali, F., 2006. Geographical distribution of Subalpine Warbler *Sylvia cantillans* subspecies in mainland Italy. *Ibis*, 148: 568-571.

Brambilla, M., Vitulano, S., Spina, F., Baccetti, N., Gargallo, G., Fabbri, E., Guialdi, F. & Randi, E., 2008. A molecular phylogeny of the *Sylvia cantillans* complex: Cryptic species within the Mediterranean basin. *Molecular Phylogenetics and Evolution*, 48: 461-472.

Bruderer, B., 2001. Recent studies modifying current views of nocturnal bird migration in the Mediterranean. *Avian Ecology and Behaviour,* 7: 11-25.

Bruderer, B. & Liechti, F., 1998. Flight behaviour of nocturnally migrating birds in coastal areas – crossing or coasting. *Journal of Avian Biology*, 29(4): 499-507.

Bruderer, B. & Liechti, F., 1999. Bird migration across the Mediterranean. In: *Proceedings of International Ornithological Congress*: 1983-1999 (N. Adam & R. Slotow, Eds.). Birdlife South Africa, Durban.

Bruderer, B., Liechti, F. & Steuri, T., 1996. Migrations aviennes à travers l'ouest Mèditerranéen – direction de vol au printemps au-dessus de Majorque. *Alauda*, 64: 7-16.

Bueno, J. M., 1990. Migración e invernada de pequeños turdinos en la Península Ibérica. I. Pechiazul (*Luscinia svecica*) y Ruiseñor Común (*Luscinia megarhynchos*). *Ardeola*, 37: 67-73.

Bueno, J. M., 1992. Migración e invernada de pequeños turdinos en la Penínsu la Ibérica. III. Colirrojo Real. (*Phoenicurus phoenicurus*). *Ardeola*, 39: 3-7.

Bueno, J. M., 1998. Migración e invernada de pequeños turdinos en la Península Ibérica. V. Petirrojo (*Erithacus rubecula*). *Ardeola*, 45: 193-200.

Busse, P., 2001. European passerine migration system – what is known and what is lacking. *Ring*, 23(1-2): 3-36.

Cantos, F. J., 1992. Migración e invernada de la familia Sylvidae (orden Passeriformes, clase Aves), en la península Ibérica. Tesis doctoral, Universidad Complutense, Madrid.

Castan, R., 1960. Les migrations pré-et post-nupciales des Pies-grieches a tete rousse *Lanius senator senator* Linné et *Lanius senator badius* Hatrlaub dans le sud tunisien. *Alauda*, 28: 129-142.

Catry, P., Campos, A., Almada, V. & Cresswell, W., 2004a. Winter segregation of migrant European robins *Erithacus rubecula* in relation to sex, age and size. *Journal of Avian Biology*, 35: 204-209.

Catry, P., Encarnaçao, V., Araujo, A., Fearon, P., Fearon, A., Armelin, M. & Delaloye, P., 2004b. Are long-distance migrant passerines faithful to their stopover sites? *Journal of Avian Biology*, 35: 170-181.

Catry, P., Lecoq, M., Araúo, A., Conway, G., Felgueiras, M., King, J. M. B., Rumsey, S., Salima, H. & Tenreiro, P., 2005. Differential migration of chiffchaffs *Phylloscopus collybita* and *P. ibericus* in Europe and Africa. *Journal of Avian Biology*, 36: 184-90.

Chernetsov, N., 2006. Habitat selection by nocturnal passerine migrants enroute: mechanisms and results. *Journal of Ornithology*, 147: 185-191.

Chernetsov, N. & Titov, N., 2001. Movement patterns of European Reed Warblers *Acrocephalus scirpaceus* and Sedge Warblers *A. schoenobaenus* before and during autumn migration. *Ardea*, 89: 509-515.

Clancey, P. A., 1950. Comments on the indigenous races of *Delichon urbica* (L.) occurring in Europe and North Africa. *Bonner Zoologische Beiträge*, 1: 39-42.

Clavell, J., 2002. *Catàleg dels ocells dels Països Catalans*. Lynx Edicions, Bellaterra.

Cortes, J. E., Finlayson, J. C., Mosquera, M. A. J. & Garcia, E. F. J., 1980. *The Birds of Gibraltar.* Gibraltar Bookshop, Gibraltar.

Cortés, J. A., Fregenal, J., Domínguez, D. & Ramírez, J., 2007. Fenología, hábitat y localización de los anillamientos de *Locustella naevia, L. luscinioides, Acrocephalus melanopogon, Acrocephalus paludicola* y *A. schoenobaenus*. Grupo de Anillamiento SEO-Málaga, Informe inédito.

Costa, S., 1990. Zarcero Icterino (*Hippolais icterina*). Noticiario Ornitológico. *Ardeola*, 37: 348.

Cramp, S. (Ed.), 1985. T*he Birds of the Western Palearctic, vol. IV: Terns to Woodpeckers*. Oxford University Press, Oxford.

Cramp, S. (Ed.), 1988. T*he Birds of the Western Palearctic, vol. V: Tyrant Flycatchers to Thrushes*. Oxford University Press, Oxford.

Cramp, S. (Ed.), 1992. *The Birds of the Western Paleartic, vol. VI: Warblers*. Oxford University Press, Oxford.

Cramp, S. (Ed.), 1998. *The complete birds of the Western Palearctic on CDROM*. Oxford University Press, Oxford.

Dejonghe, J. F. & Cornuet, J. F., 1982. La migration du Gobemouche noir en France et dans le Maghreb: une analyse des reprises. *L'Oiseaux et R. F. O.*, 52: 259-288.

Del Hoyo, J., Elliot, A. & Christie, D. A. (Eds.), 2005. *Handbook of the Birds of the World, vol. 10. Cuckoo-shrikes to Thrushes*. Lynx Edicions, Barcelona.

Del Hoyo, J., Elliott, A. & Christie, D. A. (Eds.), 2006. *Handbook of the Birds of the World, vol. 11. Old World Flycatchers to Old World Warblers*. Lynx Edicions, Barcelona.

Delingat, J., Bairlein, F. & Hedenström, A., 2008. Obligatory barrier crossing and adaptive fuel management in migratory birds: the case of the Atlantic crossing in northern wheatears (*Oenanthe oenanthe*). *Behavioral Ecology and Sociobiology*, 62: 1069-1078.

Destre, R., 1984. Les oiseaux de Tafilalt (sud-est Maroc). Etude biogéographique et écologique. Thèse 3éme cycle, Université Montpellier, Montpellier.

Didrickson, Ö., Didrickson, J. & Busse, P., 2007. Autumn migration dynamics, body mass, fat load and stopover behaviour of the Willow Warbler (*Phylloscopus trochilus*) at Manyas Kuöcenneti National Park (NW Turkey). *Ring*, 29(1-2): 67-89.

Dolz, J. C. & Dies, N., 1987. El halcón de Eleonor (Falco eleonorae, Gené) en las Islas Columbretes. In: *Islas Columbretes: contribución al estudio de su medio natural*: 241-262 (L. A. Matilla, J. L., Carretero & A. García-Carrascosa, Eds.). Generalitat Valenciana, Valencia.

Domínguez, M., Barba, E., Cantó, J. L., López, G. M. & Monrós, J. S., 2007. Seasonal interchange of the European Robin *Erithacus rubecula* populations in an evergreen holm oak forest. *Acta Ornithologica*, 42: 15-21.

Dornbusch, M., 1981. Die Ernährung einiger Klein Vogelarten in Kiefernjungbestockungen. *Beiträge zur Vogelkunde*, 27: 73-99.

Fenech, N, 1992. *Fatal flight: the Maltese obsession with killing birds*. Quiller, London.

Fernández, J. M. & Bea, A., 2003. Carricerín común *Acrocephalus schoenobaenus*. In: *Atlas de las aves reproductoras de España*: 624-625 (R. Martí & J. C. del Moral, Eds.). Dirección General de Conservación de la Naturaleza–Sociedad Española de Ornitología, Madrid.

Ferry, B., 1965. Étude d'une population d'*Hippolais polyglotta* a Dijon. *Alauda*, 33: 177-205

Finlayson, J. C., 1981. Seasonal distribution, weights and fat of passerine migrants at Gibraltar. *Ibis,* 123: 88-95.

Finlayson, J. C., 1992. *Birds of the Strait of Gibraltar*. Poyser, London.

Flegg, J., 2004. *Time to Fly. Exploring Bird Migration*. British Trust for Ornithology, Thetford.

Fracasso, G., Farronato, I., Baccetti, A. M., Massi, A., Montemaggiori, A., Roselli, A. & Spina, F., 1995. Migrazione primaverile di due sottospecie di averla capirossa attraverso il mediterraneo. *Supplemento alle Ricerche di Biologia della Selvaggina*, XXII: 501-508.

Fransson, T., 1986. Migration and wintering area of Nordic Spotted Flycatchers *Muscicapa striata*. *Vår Fågelvärld*, 45: 5-18.

Fransson, T., 1995. Timing and speed of migration in North and West European populations of *Sylvia* warblers. *J. Avian Biol.*, 26: 39–48.

Fransson, T. & Stolt, B. O., 2005. Migration routes of North European Reed Warblers *Acrocephalus scirpaceus*. *Ornis Svecica*, 15: 153-160.

Fry, C. H., Ash, J. S., & Ferguson-Lees, I. J., 1970. Spring weights of some Palaearctic migrants at Lake Chad. *Ibis*, 112: 58-82.

Garcias, P., 1992. Contribució al coneixement de l'status de les bosquetes (gènere *Hippolais*) a les Illes Balears. In: *Anuari Ornitològic de les Balears 1991*: 43-47 (Grup Balear d'Ornitologia i Defensa de la Naturalesa). GOB, Palma de Mallorca.

Gargallo, G., 1993. Identificació de la subespècie balear de Menjamosques (*Muscicapa striata balearica*). *Anuari Ornitològic de les Balears*, 8: 21-30.

Gargallo, G., 1994. On the taxonomy of the western Mediterranean islands populations of Subalpine Warbler *Sylvia cantillans. Bull. B.O.C.*, 114(1): 31-36.

Gargallo, G., 2002. Déroulement de la mue et taxonomie des populations insulaires de la Fauvette passerinette *Sylvia cantillans*. Ecole Pratique des Hautes Etudes, Montpellier.

Gauci, C. &. Sultana, J., 1976. Migration of the Subalpine Warbler *Sylvia cantillans* through Malta. *Il-Merill*, 17: 15-20.

Glutz Von Blotzheim, U. & Baeur, K. M., 1991. *Handbuch der Vögel Mitteleuropas. Band 12*. Aula-Verlag, Wiesbaden.

Gordo, O., Brotons, L., Ferrer, X. & Comas, P., 2005. Do changes in climate patterns in wintering areas affect the timing of the spring arrival of trans-Saharan migrant birds? *Global Change Biology*, 11: 12–21.

Gordo, O. & Sanz, J. J., 2008. The relative importance of conditions in wintering and passage areas on spring arrival dates: the case of long-distance Iberian migrants. *Journal of Ornithology*, 149: 199-210.

Gordo, O., Sanz, J. J. & Lobo, J. M., 2007. Environmental and geographical constraints on common swift and barn swallow spring arrival patterns throughout the Iberian Peninsula. *Journal of Biogeography*, 34: 1065-1076.

Grattarola A., Spina F. & Pilastro, A., 1999. Spring migration of the Garden Warbler (*Sylvia borin*) across the Mediterranean Sea. *Journal für Ornithologie*, 140: 419-430.

Hagemeijer, E. J. & Blair, M. J. (Eds.), 1997. *The EBBC Atlas of European Breeding Birds: Their distribution and abundance*. T. & A. D. Poyser, London.

Hahn, S., Bauer, S., & Liechti, F., 2009. The natural link between Europe and Africa — 2.1 billion birds. *Oikos*, 118: 624–626.

Hansson, B., Bensch, S., Hasselquist, D. & Nielsen B., 2002. Restricted dispersal in a long-distance migrant bird with patchy distribution, the great reed warbler. *Oecologia*, 130: 536-542.

Harris, T. & Franklin, K., 2000. *Shrikes & Bush-shrikes*. C. Helm, London.

Hedenström, A., & Alerstam, T., 1997. Optimum fuel loads in migratory birds: distinguishing between time and energy minimization. *J. Theor. Biol.*, 189: 227-234.

Hedenström, A. & Pettersson, J., 1986. Differences in fat deposits and wing pointedness between male and female Willow Warblers caught on spring migration at Ottenby, SE Sweden. *Ornis Scandinavica*, 17: 182-185.

Hedenström, A. & Pettersson, J., 1987. Migration routes and wintering areas of Willow Warblers *Phylloscopus trochilus* (L.) ringed in Fennoscandia. *Ornis Fennica*, 64: 137-143.

Hepburn, J., R., 1985. *La caccia agli uccelli migratori nei Paesi della Comunità Europea*. UNAVI, Firenze.

Hil, M., 2002. House Martin *Delichon urbica*. In: *The Migration Atlas: movements of the birds of Britain and Ireland*: 369-372 (C. V. Wernham, M. P. Toms, J. H. Marchant, J. A. Clark, G. M. Siriwardena & S. R. Baillie, Eds.), T. & A. D. Poyser, London.

Hilgerloh, G., 1991. Spring migration of passerine trans-Saharan migrants across the Strait of Gibraltar. *Ardea*, 79: 57-62.

Hjort, C., Pettersson, J., Lindström, Å. & King, J. M., 1996. Fat deposition and potential flight ranges of Blackcaps *Sylvia atricapilla* and Whitethroats *Sylvia communis* on spring migration in The Gambia. *Ornis Svecica*, 6: 137-144.

Hoballah, A., 1996. Potenzialità di sviluppo nel bacino Mediterraneo. In: *La gestione degli ambienti costieri ed insulari del Mediterraneo:* 395-404 (Montbailliu, X., & Torre, A., Eds.). Medmaravis, Alghero.

Holmgren, N. M. A. & Engström, H., 2006. Stopover behaviour of spring migrating Wood Warblers *Phylloscopus sibilatrix* on the island of Capri, Italy. *Ornis Svecica*, 16(1): 34-41.

Huin, N. & Sparks, T., 1998. Arrival and progression of the swallow *Hirundo rustica* through Britain. B*ird Study*, 45: 361-370.

ICO, 2010. *SIOC: servidor d'informació ornitològica de Catalunya*. ICO, Barcelona. (http://www.sioc.cat)

IPCC, 2007. *Climate Change 2007: The Physical Science Basis. Summary for Policymakers*. Cambridge University Press, Cambridge.

Isenmann, P., 1989a. Modalités de la migration de la Fauvette orphée (*Sylvia hortensis*) et de la Fauvette passerinette (*Sylvia cantillans*) en Camargue. *Alauda,* 57: 60-70.

Isenmann, P., 1989b. La migration du Gobemouche gris (*Muscicapa striata*) à travers la France méditerranéenne. *L'Oiseau et la Revue Française d'Ornithologie*, 59: 273-280.

Isenmann, P., Gaultier, T., El Hili, A., Azafzaf, H., Dlensi, H. & Smart, M., 2005. Oiseaux de Tunisie/Birds of Tunisia. Société d'études ornithologiques de France, Paris.

Isenmann, P. & Moali, A. (Eds.), 2000. *The birds of Algeria – Les oiseaux d'Algérie*. SEOF, Paris.

Jarry, G., 1980. Contribution des reprises enregistrées par le CRBPO de 1924 à 1977 à la connaissance des migrations de la Rousserolle effarvatte *Acrocephalus scirpaceus* et du Phragmite des joncs *Acrocephalus schoenobenus*. *Bulletin de liaison*, 10: 1-34.

Jiguet, F., Rguibi-Idrissi, H. & Provost, P., 2010. Undescribed Reed Warbler breeding in Morocco. *Dutch Birding*, 32: 29-36.

Ktitorov, P., Bairlein, F. & Dubinin, M., 2008. The importance of landscape context for songbirds on migration: body mass gain is related to habitat cover. *Landscape Ecology*, 23(2): 169-179.

Langslow, D. R., 1976. Weights of Blackcaps on migration. *Ringing & Migration*, 1: 78-91.

Lehikoinen, E., Sparks, T. H. & Zalakevicius, M., 2004. Arrival and departure dates. *Advances in Ecological Resarch*, 35: 1-31.

Liechti, F., Peter. D. & Komenda-Zehnder, S., 2003. Nocturnal bird migration in Mauritania: first records. *Journal für Ornithologie*, 144: 445-450.

Liechti, F., Steuri, T., Lopez-Jurado, C., Ribas, P. L., Reis, M. A. & Bruderer, B., 1997. Nocturnal spring migration on Mallorca – Schedules of departure and passage. *Ardeola*, 44(2): 207-213.

Lindström, Å., 2003. Fuel deposition rates in migrating birds: causes, constraints and consequences. In: *Avian migration*: 307-320 (Berthold, P., Gwinner, E., & Sonnenschein, E., Eds.). Springer-Verlag, Berlin.

López-Jurado, C. (Ed.). *Anuari Ornitològic de les Balears 2000,* vol. 15. GOB, Palma de Mallorca.

Lundberg, A. & Alatalo, R. V., 1992. *The Pied Flycatcher.* T. & A. D. Poyser, London.

Maggini, I. & Bairlein, F., 2011. Body condition and stopover of trasn-Saharan spring migrant passerines caught at a site in southern Morocoo. *Ringing & Migration*, 26: 31-37.

Maitav, A. & Izhaki, I., 1994. Stopover and fat deposition by Blackcap *Sylvia atricapilla* following spring migration over the Sahara. *Ostrich*, 65: 160-166.

Marti, R. & Del Moral, J. C. (Eds.), 2003. *Atlas de las Aves Reproductoras de España*. Dirección General de Conservación de la Naturaleza – Sociedad Española de Ornitología, Madrid.

Maumary, L., Valloton, L. & Knaus, P., 2007. *Die Vögel der Schweiz*. Schweizerische Vogelwarte, Sempach, und Nos Oiseaux, Montmollin.

Mead, M., 2002. Sand Martin *Riparia riparia*. In: *The Migration Atlas: movements of the birds of Britain and Ireland*: 369-372 (C. V. Wernham, M. P. Toms, J. H. Marchant, J. A. Clark, G. M. Siriwardena & S. R. Baillie, Eds.). T. & A. D. Poyser, London.

Messineo, A., Grattarola, A. & Spina, F., 2001. Dieci anni di Progetto *Piccole Isole*. *Biologia e Conservazione della Fauna*, 106: 1-244.

Møller, A. P., 2004. Protandry, sexual selection and climate change. *Global Change Biology*, 10: 2028-2035.

Møller, A. P., J. Brohede, J. Cuervo, J. J., De Lope, F. & Primmer, C. R., 2003. Extrapair paternity in relation to sexual ornamentation, arrival date and condition in a migratory bird. *Behavioral Ecology*, 14: 707-712.

Møller, A. P. & De Lope, F., 1999. Senescence in a short-lived migratory bird: age-dependent morphology, migration, reproduction and parasitism. *Journal of Animal Ecology*, 68: 163-171.

Moore, F., 1990. Evidence for Redetermination of Migratory Direction Following Wind Displacement. *Auk*, 107: 425-428.

Moreau, R. E., 1953. Migration in the Mediterranean area. *Ibis*, 95: 329-364.

Moreau, R. E., 1961. Problems of Mediterranean-Saharan migration. *Ibis*, 103a: 373-427.

Moreau, R. E., 1969. Comparative weights of some trans-Saharan migrants at intermediate points. *Ibis*, 111: 621-624.

Moreau, R. E., 1972. *The Palearctic-African Bird Migration Systems*. Academic Press, London.

Morgan, J. H. & Shirihai H., 1997. *Passerines and passerine migration in Eilat. International Birding and Research Center in Eilat*. Technical Publication, vol. 6(1). Eilat, Israel.

Mouritsen, H. & Larsen, O. N., 1998. Migrating young Pied Flycatchers *Ficedula hypoleuca* do not compensate for geographical displacements. *The Journal of Experimental Biology*, 201: 2927-2934.

Muntaner, J., Ferrer, X. & Martinez-Vilalta, A., 1983. *Atlas dels Ocells nidificants de Catalunya i Andorra*. Ketres, Barcelona.

Murilllo, F. & Sancho, F., 1969. Migración de *Sylvia atricapilla* y *Erithacus rubecula* en Doñana, según datos de captura. *Ardeola*, 13: 129-137.

Newton, I., 2008. *The migration ecology of birds*. Academic Press, London.

Ormerod, S., 1990. Time of passage, habitat use and weight changes of *Acrocephalus* Warblers in south Wales reedswamp. *Ringing & Migration*, 11: 1-11.

Ottosson, U., Rumsey, S. & Hjort, C., 2001. Migration of four Sylvia warblers through northern Senegal. *Ringing & Migration*, 20: 344-351.

Ottosson, U., Waldenström, J., Hjort, C. & Mcgregor, R., 2005. Garden Warbler *Sylvia borin* migration in sub-Saharan West Africa: phenology and body mass changes. *Ibis*, 147: 750-757.

Peach, W., Baillie, S., & Underhill L., 1991. Survival of British Sedge Warblers *Acrocephalus schoenobaenus* in relation to west African rainfall. *Ibis*, 133: 300-305.

Pearson, D. P., 2006. Sedge Warbler Acrocephalus schoenobaenus. In *Handbook of the Birds of the World, vol 11. Old World Flycatchers to Old World Warblers*: 617-618 (J. del Hoyo, A. Elliot & D. A. Christie, Eds.). Lynx Edicions, Barcelona.

Pérez-Tris, J., Carbonell, J. R. & Tellería, J. L., 2000. Abundance distribution, morphological variation, and juvenile condition of robins *Erithacus rubecula* in their Mediterranean range boundary. *Journal of Biogeography*, 27: 879-888.

Pérez-Tris, J., Ramirez, A. & Tellería, J. L., 2003. Are Iberian chiffchaffs *Phylloscopus collybita brehmii l*ong-distance migrants? An analysis of flight-related morphology. *Bird Study*, 50: 146-152.

Pettersson, J., Hjort, C., Gezelius, L. & Johansson, J., 1990. *Spring Migration of Birds on Capri*. Degerhamn: Ottenby Bird Observatory.

Pilastro, A., Macchio, S., Massi, A., Montemaggiori, A. & Spina, F., 1998. Spring migratory routes of eight trans-saharan passerines through the central and western Mediterranean; results from a network of insular and coastal ringing sites. *Ibis*, 140: 591-598.

Pilastro, A. & Spina, F., 1997. Ecological and morphological correlates of residual fat reserves in passerine migrants at their spring arrival in southern Europe. *Journal of Avian Biology*, 28: 309-318.

Pollo, R. & Bombieri, R., 2000. Survival, phenology and philopatry of the Melodious Warbler *Hippolais polyglotta* in North eastern Italy. *Avocetta*, 24: 45-50.

Procházka, P. & Reif, J., 2002. Movements and settling patterns of Sedge Warblers (*Acrocephalus schoenobaenus*) in the Czech Republic and Slovakia –an analysis of ringing recoveries. *Ring*, 24(2): 3-13.

Purroy, F. J., 2003. Bisbita arbóreo *Anthus trivialis*. In: *Atlas de las aves reproductoras de España*: 394-395 (R. Martí & J. C. del Moral, Eds.). Dirección General de Conservación de la Naturaleza – Sociedad Española de Ornitología, Madrid.

Puzzanghera, R., 1991. Il Canapino Hippolais polyglotta arriva in Italia dalla Spagna? *U.D.I.*, 16: 72-80.

Rguibi-Idrissi, H., 2002. Analyse comparative de la migration de quelques passereaux au Maroc à l'aide des données de baguage et d'un suivi dans deux zones humides. Thèse de Doctorat. Univ. Rabat, Maroc.

Rguibi-Idrissi, H., Dakki, M. & Barlein, F., 2007. Migration et hivernage de quelques passereaux au Maroc: Mise au point à partir des données de baguage-reprise. *Ostrich*, 78(2): 343-349.

Rguibi-Idrissi, H., Julliard, R. & Bairlein, F., 2003. Variations in the stopover duration of Reed warblers *Acrocephalus scirpaceus* in Morocco: effects of season, age and site. *Ibis*, 145 : 203-215.

Rguibi-Idrissi, H., Lefebvre, G. & Poulin, B., 2004. Diet of Reed warblers *Acrocephalus scirpaceus* at two sites in Morocco during autumn migration. *Revue d'Ecology (La Terre et la Vie)*, 59: 491-502.

Rguibi-Idrissi, H., Thévenot, M., Bairlein, F. & Dakki, M., 2002. Premiers cas de nidification de la Rousserolle effarvatte Acrocephalus scirpaceus à Sidi Bou Rhaba (littoral nord atlantique du Maroc). *Alauda*, 70(1): 223-225.

Robson, D. & Barriocanal, C., 2008. The influence of environmental conditions on the body mass of Barn Swallows (*Hirundo rustica*) during spring migration. *Journal of Ornithology*, 149(3): 473-478.

Robson, D. & Barriocanal, C., 2010. Ecological conditions in wintering and passage areas as determinants of timing of spring migration in trans-Saharan migratory birds. *Journal of Animal Ecology*, 80: 320-331.

Robson, D., Barriocanal, C., Garcia, O. & Villena, O., 2001. The spring stopover of the Reed Warbler *Acrocephalus scirpaceus* in northeast Spain. *Ringing Migration*, 20: 233-238.

Rodríguez, M., 1985. Weights and fat accumulation of Blackcaps *Sylvia atricapilla* during migration through southern Spain. *Ringing & Migration*, 6: 33-38.

Rubolini, D., Gardiazábal, A., Pilastro, A. & Spina, F., 2002. Ecological barriers shaping fuel stores in barn swallows *Hirundo rustica* following the central and western Mediterranean flyways. *Journal of Avian Biology*, 33: 15-22.

Rubolini, D., Spina, F. & Saino, N., 2004. Protandry and sexual dimorphism in trans-Saharan migratory birds. *Behavioral Ecology*, 15: 592-601.

Rubolini, D., Spina, F. & Saino, N., 2005. Correlates of timing of spring migration in birds: a comparative study of trans-Saharan migrants. *Biological Journal of the Linnean Society*, 85(2): 199-210.

Sætre, G. P., Borge, T., Haavie, J. & Johnsen, A., 2001. Speciation, introgressive hybridization and nonlinear rate of molecular evolution in flycatchers. *Molecular Ecology*, 10: 737-749.

Saino, N., Rubolini, D., Von Hardenberg, J., Ambrosini, R., Provenzale, A., Romano, M. & Spina, F., 2010. Spring migration decisions in relation to weather are predicted by wing morphology among trans-Mediterranean migratory birds. *Functional Ecology*, 24: 658-669.

Saino, N., Szép, T., Ambrosini, R., Romano, M. & Møller, A. P., 2004. Ecological conditions during winter affect sexual selection and breeding in a migratory bird. *Proceedings of the Royal Society B*, 271: 681-686.

Salewski, V., Almasi, B., Heuman, A., Thoma, M. & Schlageter, A., 2007. Agonistic behaviour of Palaearctic passerine migrants at a stopover site suggests interference competition. *Ostrich*, 78(2): 349-355.

Salewski, V., Bairlein, F. & Leisler, B., 2002. Different wintering strategies of two Palearctic migrants in West Africa – a consequence of foraging strategies? *Ibis*, 144: 85-93.

Salewski, V. & Schaub, M., 2007. Stopover duration of Palearctic passerine migrants in the western Sahara. Independent of fat stores? *Ibis*, 149: 223-236.

Salewski, V., Schmaljohann, H. & Liechti, F., 2010. Spring passerine migrants stopping over in the Sahara are not fall-outs. *Journal of Ornithology*, 151: 371-378.

Sanz, J. J., Potti, J., Merino, S. & Frias, O., 2003. Climate change and fitness components of a migratory bird breeding in the Mediterranean region. *Global Change Biology*, 9: 461-472.

Schaub, M. & Jenni, L., 2000. Body mass of six long-distance migrant passerine species along the autumn migration route. *Journal of Ornithology*, 141: 441-460.

Schaub, M. & Jenni, L., 2001. Stopover duration of three warbler species along their autumn migration route. *Oecologia*, 128: 217-227.

Schmaljohann, H., Liechti, F. & Bruderer, B., 2007a. Songbird migration across the Sahara: the non-stop hypothesis rejected!. *Proceedings of the Royal Society B*, 274: 735-739.

Schmaljohann, H., Liechti, F. & Bruderer, B., 2007b. Daytime passerine migrants over the Sahara – are these diurnal migrants or prolonged flights of nocturnal migrants. *Ostrich*, 78: 357–362.

Schüz, E., 1971. Einzelabshnitte aus dem Zuggeschehen. In: *Grundriss der Vogelzugskunde*: 111-182 (E. Schüz, Ed.). Pare, Berlin und Hamburg.

Schwilch, R., & Jenni, L., 2001. Low initial refuelling rate at stopover sites: a methodological effect? *Auk*, 118: 698-708.

Shirihai, H., Gargallo, G., Helbig, A. J., Harris, A. & Cottridge, D., 2001. *Sylvia warblers*. Christopher Helm, London.

Sillet, T., S., & Holmes, R., T., 2002. Variation in survivorship of a migratory songbird throughout its annual cycle. *J. Anim. Ecol.,* 71:296–308.

Simms, E., 1985. *Brifish Warblers*. Collins, Londres.

Smith, G. A., 1979. Spring weights of selected trans-Saharan migrants in north west Morocco. R*inging Migration*, 2: 151-155.

Smith, K. D., 1965. On the birds of Morocco. *The Ibis,* 107: 493-526.

Smith, K. D., 1968. Spring migration through south east Morocco. *Ibis*, 110: 452-492.

Smith, V. W., 1966. Autumn and spring weights of some Palaearctic migrants in Central Nigeria. *Ibis*, 108: 109-111.

Snow, D. W. & Perrins, C. M., 1998. *The birds of the western Palearctic, Concise edition*. Oxford University Press, Oxford.

Sparks, T. H., Roberts, D. R. & Crick, H. Q. P., 2001. What is the value of first arrival dates of spring migrants in phenology? *Avian Ecology and Behavior,* 7: 75-85.

Sparks, T. & Tryjanowski, P., 2007. Patterns of spring arrival dates differ in two hirundines. *Climate Research*, 35(1-2): 159-164.

Speich, S., 1999. Temporal and Spatial Pattern of Nocturnal Bird Migration across the Western Mediterranean Sea Studied by Radar. Diploma Thesis. Zoological Institute University of Basel, Switzerland.

Spina, F., 2011. Joint ringing efforts to unravel complex migratory patterns cross ecological barriers: the potential of networking. *J. Ornithol.*, 152 (Suppl 1): 41–48.

Spina, F., Massi, A. & Montemaggiori, A., 1994. Back from Africa: Who's running ahead? Aspects of differential migration of sex and age classes in Palearctic-African spring migrants. *Ostrich*, 65: 137-150.

Spina, F., Massi, A., Montemaggiori, A. & Baccetti, N., 1993. Spring migration across central Mediterranean: general results from the "Proggeto *Piccole Isole*". *Vogelwarte*, 37: 1-94.

Spina, F. & Volponi, S., 2008. *Atlante della Migrazione degli Uccelli in Italia, vol. 1: Non-Passeriformi*. ISPRA-MATTM, Roma.

Spina, F. & Volponi, S., 2009. *Atlante della Migrazione degli Uccelli in Italia, vol. 2: Passeriformi*. ISPRA-MATTM, Roma.

Sultana, J., & Gauci, C., 1982. *A New Guide to the Birds of Malta*. The Ornithological Society, Malta

Svensson, L., 1992. *Identification Guide to European, 4th edition*. Stockholm.

Svensson, L., 2001. The correct name of the Iberian chiffchaff Phylloscopus ibericus Ticehurst 1937, its identification and new evidence of its winter grounds. *Bulletin of the British Ornithologists' Club*, 121(4): 281-296.

Szép, T., Møller, A. P., Piper, S., Nuttall, R., Szabó, Z. D. & Pap, P. L., 2006. Searching for potential wintering and migration areas of a Danish barn swallow population in South Africa by correlating NDVI with survival estimates. *Journal of Ornithology*, 147: 245-253.

Tellería, J. L., Asensio, B. & Díaz, M., 1999. *Aves Ibéricas, vol II. Paseriformes*. J. M. Reyero Editor, Madrid.

Tellería, J. L. & Carbonell, R., 1999. Morphometric variation of five Iberian blackcap *Sylvia atricapilla* populations. *Journal of Avian Biology*, 30: 63-71.

Thévenot, M. & Thouy, P. 1974. Nidification ou hivernage d'espèces peu connues ou nouvelles pour le Maroc. *Alauda*, 42: 51-56.

Thévenot, M., Vernon, R. & Bergier, P., 2003. *The Birds of Morocco. BOU Checklist, no. 20*. British Ornithologists' Union and British Ornithologists' Club, The Natural History Museum, Tring.

Tøttrup, A. P. & Thørup, K., 2008. Sex-differentiated migration patterns, protandry and phenology in North European songbird populations. *Journal of Ornithology*, 149: 161-167.

Trösch, B., Lardelli, R., Liechti, F., Peter, D. & Bruderer, B., 2005. Spatial and seasonal variation in nocturnal autumn and spring migration patterns in the Western Mediterranean area: a moon-watching survey. *Avocetta*, 29: 63-73.

Turner, A. K., 2006. *The Barn Swallow*. T. & A. D. Poyser, London.

Urban, E. K., Fry, C. H. & Keith, S. (Eds.), 1997. *The birds of Africa, vol. 5. Thrushes to Puffback Flycatchers*. Academic Press, London.

Van den Brink, B., Bijlsma, R. G. & van der Have, T. M., 1998. European songbirds and Barn Swallows Hirundo rustica in Ghana: a quest for Constant Effort Sites and swallow roosts in December/ January 1996/97. *WIWO report,* 58: 155.

Vaurie, C., 1959. *The Birds of the Paleartic Fauna. Passeriformes*. H. F. & G. Witherby Limited, London.

Waldenström, J., Ottosson, U. & Haas, F., 2004. Morphometrical data from 30 bird species on spring migration in northern Tunisia. *Ornis Svecica*, 14: 129-133.

Wernham, C. V., Toms, M. P., Marchant, J. H., Clark, J. A., Siriwardena, G. M. & Baillie, S. R. (Eds.), 2002. *The Migration Atlas: movements of the birds of Britain and Ireland*. T. & A. D. Poyser, London.

Wood, B., 1992. Yellow wagtail Motacilla flava migration from west Africa to Europe –Pointers towards a conservation strategy for migrants on passage. *Ibis*, 134: 66-76.

Wood, B., 2002. Yellow Wagtail Motacilla Flava. In: *The Migration Atlas: movements of the birds of Britain and Ireland*: 369-372 (C. V. Wernham, M. P. Toms, J. H. Marchant, J. A. Clark, G. M. Siriwardena & S. R. Baillie, Eds.). T. & A. D. Poyser, London.

Yosef, R., & Chernetsov, N., 2004. Stopover ecology of migratory Sedge Warblers (*Acrocephalus schoenobaenus*) at Eilat, Israel. *Ostrich*, 75: 52–56.

Yosef, R., & Chernetsov, N., 2005. Longer is fatter: body mass changes of migrant Reed Warblers (*Acrocephalus scirpaceus*) staging at Eilat, Israel. *Ostrich*, 76: 142–147.

Yosef, R., Markovets, M., Mitchell, L. & Tryjanowski, P., 2006. Body condition as a determinant for stopover in Bee-eaters on spring migration in the Arava Valley, southern Israel. *Journal of Arid Environments*, 62: 401-411.

Zink, G., 1973. *Der Zug europäischer Singvögel. Ein Atlas der Wiederfunde beringter Vögel. Part 1*. Vogelzug-Verlag, Möggingen.

Zink, G., 1975. *Der Zug europäischer Singvögel. Ein Atlas der Wiederfunde beringter Vögel. Part 2.* Vogelzug-Verlag, Möggingen.

Zink, G., 1981. *Der Zug europäischer Singvögel. Ein Atlas der Wiederfunde beringter Vögel. Part 3*. Vogelzug-Verlag, Möggingen.

Zink, G., 1985. *Der Zug europäischer Singvögel. Ein Atlas der Wiederfunde beringter Vögel. Part 4*. Vogelzug-Verlag, Möggingen.

Zwarts, L., Bijlsma, R. G., Van der Kamp, J. & Wymenga, E., 2009. *Living on the edge: Wetlands and birds in a changing Sahel*. KNNV Publishing, Zeist.

Appendices

Appendix 1. Mean, SD and sample size for each species, pentad and variable (third primary length, body mass and fat).

Streptopelia turtur

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean															119.6			
SD															2.9			
n															4			
Columbrets																		
Mean									126.1	127.2	127.1	125.5		125.4	125.8	126.6	126.4	
SD									2.2	3.9	4.7	3.8		4.0	3.5	3.1	3.5	
n									6	34	44	63		79	65	21	13	
Dry Balearics																		
Mean								127.6	126.1	127.6	125.8	125.2		125.4	124.7	124.1		
SD								1.9	3.8	3.6	4.4	4.3		4.2	3.9	3.3		
n								12	16	50	81	121		130	119	143		
Wet Balearics																		
Mean												125.2						
SD												5.2						
n												6						
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean													1.0	1.6				
SD													0.8	0.8				
n													4	4				
Columbrets																		
Mean									0.2	0.6	0.4	0.8	0.8	0.9	1.1	0.4		
SD									0.4	0.8	0.7	0.6	0.6	0.6	1.0	0.8		
n									5	37	59	63	64	84	32	4		
Dry Balearics																		
Mean								1.5	1.0	1.1	0.9	0.9	1.2	0.8	0.9	0.3		
SD								0.8	0.6	0.7	0.6	0.7	1.0	0.7	0.8	0.5		
n								10	11	44	80	75	123	76	96	4		
Wet Balearics																		
Mean												0.8						
SD												0.8						
n												6						
Chafarinas																		
Mean																		
SD																		
n																		
Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean													132.7	138.1				
SD													13.8	6.0				
n													4	3				
Columbrets																		
Mean									121.3	130.4	136.4	126.7	131.5	131.0	137.6	142.0		
SD									11.7	12.7	16.6	16.5	18.0	15.8	15.8	14.8		
n									7	34	65	53	73	37	32	13		
Dry Balearics																		
Mean								128.8	133.4	132.0	128.3	125.1	129.3	129.2	130.7	124.3	118.8	118.3
SD								18.7	12.4	12.8	12.0	14.0	13.9	15.3	14.7	19.7	9.8	14.8
n								11	18	68	92	151	160	155	160	11	4	4
Wet Balearics																		
Mean												128.9						
SD												10.0						
n												6						
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Merops apiaster

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean										105.6	108.1	109.9	108.5	109.6	107.3	111.5	109.4	109.5
SD										5.2	4.64.4		6.1	4.8	5.6	2.6	5.0	4.7
n									9	7	18		13	23	23	18	9	11
Columbrets																		
Mean											112.0	109.4	109.3					
SD												4.1	2.2	2.5				
n											6	10	6					
Dry Balearics																		
Mean							108.1	105.8	106.6	109.6	109.7	109.3	109.5	110.2	109.4			
SD							4.6	5.4	2.3	3.5	3.3	3.4	3.5	3.4	3.7			
n							6	5	4	46	102	150	88	66	27			
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean							108.7											
SD							2.5											
n							5											
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean										0.3	0.8	0.6	0.9	0.8	0.9	0.2	0.8	0.4
SD										0.5	0.6	0.5	0.6	0.8	0.7	0.4	0.7	0.5
n										9	12	18	16	23	23	19	8	11
Columbrets																		
Mean											0.9	0.6	0.4					
SD											0.6	0.2	0.2					
n											7	10	6					
Dry Balearics																		
Mean							1.8	0.6	0.3	1.1	1.3	1.1	1.1	1.0	1.0			
SD							0.8	0.9	0.5	0.4	0.6	0.4	0.5	0.6	0.8			
n							6	5	4	58	125	160	157	76	28			
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean							0.8							0.0	0.0			
SD							0.4							0.0	0.0			
n							5							4	3			
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean										57.4	52.5	53.9	52.7	55.0	53.4	53.6	54.2	56.5
SD										4.6	3.6	7.2	4.3	4.5	3.4	3.6	3.8	5.3
n										9	12	18	16	23	21	19	8	11
Columbrets																		
Mean											43.6	49.0	43.9					
SD											2.5	4.0	2.0					
n											6	9	6					
Dry Balearics																		
Mean							53.9	48.5	52.0	57.5	55.7	56.0	55.2	54.5	56.0			
SD							4.3	5.3	2.1	4.2	4.5	4.3	5.3	5.4	6.5			
n							6	5	3	62	124	165	156	71	29			
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean							52.5							57.4	58.3			
SD							3.2							2.7	1.2			
n							5							4	3			
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Upupa epops

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean			109.0		113.9	111.6	111.6		112.0	109.8	112.0	114.0	113.6	109.4				
SD			3.0		6.5	4.4	3.9		3.8	4.1	3.2	3.4	4.6	4.0				
n			3		4	9	7		13	4	7	8	7	10				
Columbrets																		
Mean					114.5	113.0	112.6	108.8	110.6	112.2	110.5	113.2		110.0				
SD					1.8	2.8	6.5	4.9	4.1	3.8	6.1	2.7		4.2				
n					4	12	8	8	7	8	3	4		4				
Dry Balearics																		
Mean				112.3	112.5	111.1	111.8	110.2	110.9	110.8	110.2	110.1	111.3	108.8	111.5		115.0	
SD				3.1	3.9	4.4	4.2	4.4	5.0	4.9	5.3	5.2	3.5	3.7	3.3		3.0	
n				10	10	30	70	48	34	62	29	34	24	13	8		3	
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean			0.0		1.0	0.3	1.7		1.1	0.6	0.6	0.8	0.6	0.7	0.3			
SD			0.0		1.4	0.5	1.0		0.9	0.7	0.7	0.8	0.5	1.1	0.6			
n			3		4	9	7		13	5	8	9	8	13	3			
Columbrets																		
Mean								0.8	0.4	0.6	0.0	0.4	0.2					
SD								0.4	0.8	0.5	0.0	0.5	0.3					
n								6	7	9	5	4	3					
Dry Balearics																		
Mean				0.6	0.9	0.9	1.0	1.0	1.0	0.7	0.9	0.7	0.6	0.4	0.5	1.0	0.6	
SD				0.7	0.7	0.6	0.8	0.8	1.0	0.6	0.7	0.7	0.8	0.5	0.7	0.0	0.9	
n				11	12	30	69	52	40	77	41	51	31	21	10	3	5	
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean			60.5		69.9	65.3	65.4		69.4	57.1	68.3	68.1	68.4	69.8	64.2			
SD			1.7		7.5	4.5	6.1		7.9	5.1	4.6	5.7	3.8	5.3	6.9			
n			3		4	9	7		13	4	8	9	8	13	3			
Columbrets																		
Mean					62.0	67.4	60.5	56.7	61.6	59.9	60.8		62.4					
SD					4.6	8.4	6.0	5.8	9.8	7.5	8.9		6.9					
n					4	12	10	8	7	10	5		4					
Dry Balearics																		
Mean				67.3	57.3	62.6	64.3	64.7	66.6	64.6	63.1	62.0	63.8	62.6	63.8	61.8	66.1	
SD				7.7	7.1	9.1	8.0	7.8	8.5	6.3	7.4	7.7	5.5	5.7	8.3	9.4	6.9	
n				10	11	29	68	50	40	77	40	50	31	20	11	3	5	
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Riparia riparia

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							83.9	83.9	82.9	83.1	83.1	82.5	82.9	83.4	83.9	84.2	82.2	83.2
SD							2.0	1.6	2.1	2.3	2.3	2.6	2.3	2.7	1.6	2.8	2.9	0.8
n							10	7	54	138	84	87	62	50	21	3	3	3
Columbrets																		
Mean									82.2									
SD									1.5									
n									3									
Dry Balearics																		
Mean										83.4	80.7	84.3		84.4	82.9			
SD										2.7	1.5	1.3		3.1	2.4			
n										18	3	3		7	21			
Wet Balearics																		
Mean												82.5	82.1					
SD												1.2	2.5					
n												10	4					
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean											83.7							
SD											2.6							
n											3							

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							3.1	3.8	1.6	2.3	3.5	3.6	3.0	3.0	3.3	3.7	4.0	3.7
SD							1.4	0.9	1.0	1.2	1.2	1.0	1.2	0.9	0.8	0.6	1.0	0.6
n							10	8	54	142	100	90	63	53	21	3	3	3
Columbrets																		
Mean									0.3									
SD									0.5									
n									4									
Dry Balearics																		
Mean										0.9	1.0	1.6	1.8	1.3	1.2			
SD										0.8	1.0	1.5	2.9	1.4	1.1			
n										19	3	5	4	7	22			
Wet Balearics																		
Mean												1.7	4.3					
SD												1.2	0.5					
n												11	4					
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean											1.7							
SD											0.6							
n											3							

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							14.2	13.2	12.1	12.8	14.2	13.8	13.6	13.8	13.9	15.0	16.0	12.9
SD							1.4	1.0	0.8	1.3	1.1	0.9	1.2	1.1	0.8	0.5	0.4	0.2
n							10	7	54	141	99	89	61	51	21	3	3	3
Columbrets																		
Mean									10.4									
SD									1.1									
n									4									
Dry Balearics																		
Mean										10.8	11.3	11.8	11.9	11.5	12.1			
SD										1.1	1.6	0.9	2.6	1.5	1.4			
n										17	3	5	4	7	21			
Wet Balearics																		
Mean												11.9	12.8					
SD												1.3	0.9					
n												10	4					
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean											12.2							
SD											0.4							
n											3							

Appendix 1. (Cont.).

Hirundo rustica

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean				97.0	95.8	96.1	97.0	96.5	96.6	95.5	95.3	95.7	95.9	95.9	95.6	96.8	95.6	96.8
SD				1.8	2.9	2.5	2.8	2.7	2.6	2.8	2.6	2.7	2.5	2.5	2.8	2.6	2.6	2.9
n				4	26	50	140	256	487	1,107	649	786	870	691	295	96	52	50
Columbrets																		
Mean							94.7	94.7	96.0	95.4	95.9	95.8	95.1	95.5	95.5			
SD							2.9	2.7	2.7	3.8	2.8	3.2	2.3	2.4	3.0			
n							3	9	48	38	64	40	71	44	14			
Dry Balearics																		
Mean					94.5	96.4	96.3	96.2	96.0	95.7	95.8	95.2	95.8	95.7	95.0	94.3		
SD					1.5	1.8	3.1	3.0	2.8	2.9	2.9	3.2	2.6	2.8	2.5	3.0		
n					8	8	52	54	152	247	263	258	231	179	99	5		
Wet Balearics																		
Mean						95.8	96.5	96.6		96.1	96.5	96.1	96.4	96.3				
SD						2.3	2.2	2.6		2.5	2.8	2.9	3.2	2.6				
n						3	15	40		61	61	87	52	21				
Chafarinas																		
Mean													95.4					
SD													1.7					
n													6					
N Morocco																		
Mean							93.3	94.3	95.4	96.6	95.3	95.7	95.8	94.7				
SD							2.1	2.5	1.9	1.4	2.3	2.5	2.4	3.0				
n							17	4	9	6	8	14	40	6				
S Morocco																		
Mean							94.5	94.8	91.9	93.2	93.6	93.9						
SD							2.9	2.7	2.3	2.5	2.6	2.5						
n							17	36	6	21	54	69						

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean				2.0	2.5	2.5	2.6	3.0	1.9	1.9	2.9	2.9	2.2	2.4	2.6	2.7	2.6	2.6
SD				0.0	1.1	0.7	1.1	1.0	1.0	1.3	1.4	1.1	1.4	1.1	1.2	1.0	1.3	1.0
n				4	26	51	141	260	488	1,135	851	791	1,066	715	296	96	52	50
Columbrets																		
Mean								2.0	0.6	0.8	0.4	0.4	0.5	0.9	0.4			
SD								0.8	1.0	0.9	0.8	0.5	0.7	0.8	0.4			
n								4	77	53	69	43	78	48	12			
Dry Balearics																		
Mean				0.7	1.5	1.1	2.0	1.5	1.5	1.3	1.6	1.6	1.9	2.0	1.9	3.4		
SD				0.6	0.5	0.8	0.9	0.9	1.1	1.1	1.1	1.1	1.4	1.3	1.3	1.8		
n				3	8	8	55	56	160	279	280	316	292	199	105	5		
Wet Balearics																		
Mean							2.4	1.9		2.0	2.3	2.2	2.8	2.8				
SD							0.5	0.5		1.2	0.9	1.0	1.0	1.1				
n							15	40		61	61	138	52	21				
Chafarinas																		
Mean													2.2					
SD													1.2					
n													6					
N Morocco																		
Mean							1.3	3.5	2.2	4.8	4.2	3.9	4.3	3.6				
SD							0.6	1.3	0.6	0.8	1.2	0.9	1.2	1.9				
n							16	4	10	26	8	15	40	6				
S Morocco																		
Mean							2.1	2.4	2.3	2.8	2.3	2.7						
SD							0.7	1.0	0.8	1.0	1.1	1.1						
n							21	42	6	21	55	72						

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean				19.0	18.6	18.2	18.4	18.4	17.4	17.9	19.2	18.9	18.6	18.5	19.2	19.2	19.0	18.5
SD				1.7	1.2	1.4	1.8	1.5	1.5	1.7	1.8	1.6	1.7	1.7	1.7	1.8	1.8	1.7
n				4	26	45	139	258	483	1,131	842	783	891	698	294	96	52	50
Columbrets																		
Mean							15.1	16.4	16.0	15.9	16.0	15.3	15.2	15.1	15.3			
SD							1.3	1.9	1.6	1.5	1.7	1.7	1.6	1.6	1.6			
n							4	11	72	60	68	47	74	48	14			
Dry Balearics																		
Mean				15.7	16.3	16.7	17.2	17.0	16.9	16.9	17.0	17.0	17.0	17.3	17.6	18.2		
SD				1.1	2.6	0.8	1.3	1.7	1.9	1.9	1.7	1.9	1.9	2.1	1.8	1.5		
n				3	7	8	54	56	160	277	277	316	284	189	103	5		
Wet Balearics																		
Mean						19.9	18.0	19.1		18.1	18.2	18.4	19.2	18.5				
SD						2.4	1.3	1.5		2.0	1.4	1.8	1.9	2.0				
n						3	15	40		60	61	117	51	21				
Chafarinas																		
Mean													17.7					
SD													1.5					
n													6					
N Morocco																		
Mean							17.0	19.9	18.1	20.7	21.0	20.2	21.8	20.8				
SD							1.5	0.8	1.8	1.1	1.5	1.8	1.9	2.1				
n							16	4	10	26	7	15	40	6				
S Morocco																		
Mean							18.7	18.9	17.9	19.4	18.6	19.5						
SD							1.8	1.7	1.6	1.8	1.7	2.2						
n							21	42	6	21	56	72						

Appendix 1. (Cont.).

Delichon urbica

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							80.8		83.7	81.8	82.0		82.1		80.5			81.8
SD							1.8		1.9	2.5	3.3		3.6		1.5			1.5
n							5		17	63	11		11		3			10
Columbrets																		
Mean									81.4	84.8	80.5		83.2	83.9	82.5			
SD									1.2	2.5	2.2		4.4	3.3	2.5			
n									5	7	5		7	4	16			
Dry Balearics																		
Mean							80.5		81.3	81.9	81.9	82.2	82.1	82.5	82.4	83.5		
SD							0.5		2.3	3.3	3.3	2.8	2.6	3.0	3.8	1.2		
n							3		9	49	27	17	26	23	30	5		
Wet Balearics																		
Mean					82.1	80.7				81.7	83.9							
SD					1.8	2.6				1.4	3.6							
n					5	5				5	12							
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean							83.4											
SD							2.4											
n							14											

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							1.0		1.9	1.0	0.2		2.6		2.3			1.4
SD							0.0		1.1	1.0	0.4		1.1		0.6			1.2
n							5		17	65	11		11		3			11
Columbrets																		
Mean									0.2	0.0	0.3		0.8	0.6	0.3			
SD									0.4	0.0	0.4		0.6	0.4	0.5			
n									5	12	5		8	5	15			
Dry Balearics																		
Mean							1.3		0.8	0.9	1.4	1.2	0.8	1.2	0.9	1.4		
SD							0.6		0.8	0.8	1.1	1.1	1.1	1.1	0.9	1.1		
n							3		11	52	27	19	45	31	34	5		
Wet Balearics																		
Mean					3.2	3.2				2.2	1.8							
SD					1.3	1.3				1.3	0.7							
n					5	5				5	13							
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean													1.7					
SD													0.6					
n													3					
S Morocco																		
Mean							0.9											
SD							1.1											
n							14											

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							14.8		16.0	15.8	15.0		16.6		16.3			16.5
SD							1.7		1.3	1.3	1.5		1.9		0.4			1.7
n							5		17	65	11		11		3			10
Columbrets																		
Mean									14.0	14.2	13.5		13.9	13.1	13.7			
SD									1.6	1.5	1.0		1.6	1.1	1.4			
n									5	12	5		8	5	16			
Dry Balearics																		
Mean							13.4		14.6	14.4	15.0	14.6	14.7	14.9	15.3	18.1		
SD							1.5		1.0	1.6	1.4	2.1	1.7	1.6	1.7	1.1		
n							3		10	52	27	19	44	31	32	5		
Wet Balearics																		
Mean					17.9	16.8				16.7	16.3							
SD					1.0	0.6				1.6	2.0							
n					5	5				5	13							
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean													14.9					
SD													0.5					
n													3					
S Morocco																		
Mean							15.0											
SD							1.0											
n							14											

Appendix 1. (Cont.).

Anthus trivialis

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean								68.7	69.4	67.6	66.4	67.3	65.3	64.8	66.5			
SD								1.9	2.4	2.1	3.8	2.4	3.1	1.4	0.9			
n								5	7	15	4	7	6	6	3			
Columbrets																		
Mean									66.9	66.2	66.7	65.5	65.9	66.5	66.5			
SD									2.1	2.0	2.4	2.7	2.1	2.2	2.0			
n									11	26	33	23	38	32	22			
Dry Balearics																		
Mean							67.3	67.6	67.7	67.0	66.8	67.0	66.6	66.6	66.2	65.2		
SD							2.1	2.5	2.2	2.3	2.7	2.8	2.4	2.2	2.1	1.8		
n							17	45	60	145	74	78	79	65	35	8		
Wet Balearics																		
Mean										71.0		66.0						
SD										1.8		2.6						
n										3		3						
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean							69.6											
SD							1.6											
n							5											

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean								3.2	1.3	2.3	2.4	2.9	2.0	3.0	3.0			
SD								1.3	1.0	1.5	1.4	1.7	1.3	0.9	0.0			
n								5	7	15	5	7	6	6	3			
Columbrets																		
Mean									0.6	0.9	1.5	1.0	1.8	1.5	1.4			
SD									0.9	1.2	1.2	1.0	1.2	1.0	1.2			
n									14	28	34	33	41	34	21			
Dry Balearics																		
Mean							2.1	2.2	2.0	1.6	1.6	1.8	2.0	2.3	2.3	1.6		
SD							1.5	1.8	1.5	1.5	1.4	1.5	1.5	1.6	1.4	1.2		
n							18	49	61	158	85	96	98	71	41	12		
Wet Balearics																		
Mean										3.0		3.7						
SD										1.0		1.5						
n										3		3						
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean							1.4											
SD							0.5											
n							5											

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean								23.7	20.5	21.5	21.0	23.0	20.6	21.4	21.9			
SD								2.5	1.6	2.6	3.3	3.4	2.5	1.2	2.0			
n								5	6	15	5	6	6	6	3			
Columbrets																		
Mean									19.2	18.3	20.4	19.1	20.3	20.1	20.1			
SD									2.3	3.0	3.7	2.8	3.0	3.0	3.0			
n									16	34	35	33	41	33	23			
Dry Balearics																		
Mean							20.4	21.2	20.9	20.3	20.5	21.0	20.7	20.8	20.9	20.3		
SD							3.3	3.0	2.7	2.6	2.6	2.7	2.3	2.2	2.5	1.3		
n							18	46	58	157	83	95	96	70	41	10		
Wet Balearics																		
Mean										22.9		21.4						
SD										1.2		1.0						
n										3		3						
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean							21.6											
SD							2.3											
n							5											

Appendix 1. (Cont.).

Motacilla flava

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							64.5	61.3	61.7	61.0	60.7	59.4	60.9	61.2	60.2	61.2	61.9	61.0
SD							1.5	2.9	1.6	2.7	2.1	2.5	2.7	2.3	2.3	2.0	2.1	2.0
n							3	5	6	20	29	24	35	28	22	16	12	19
Columbrets																		
Mean									60.4	58.3	59.7	59.5	60.6	60.0	60.0			
SD									2.7	2.5	2.1	2.2	2.4	3.4	1.7			
n									10	9	13	18	31	24	12			
Dry Balearics																		
Mean									61.1	60.0	60.3	61.5	59.8	60.4	59.7		59.3	
SD									1.4	2.8	2.5	2.6	2.4	2.6	2.2		2.1	
n									8	12	40	26	27	37	47		3	
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean														60.2				
SD														1.8				
n														3				
S Morocco																		
Mean							58.7	60.9			58.8	58.3						
SD							3.2	2.5			2.6	4.2						
n							21	7			6	24						

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							2.3	3.2	2.5	1.5	0.9	2.1	2.6	2.3	1.9	1.1	1.1	1.0
SD							2.1	0.8	1.4	1.1	0.9	1.4	1.5	1.2	1.3	0.7	0.9	0.7
n							3	5	6	20	30	24	35	30	22	16	12	20
Columbrets																		
Mean									0.8	1.0	0.6	1.3	1.3	0.7	0.7			
SD									1.3	1.1	0.6	1.2	1.1	0.7	0.7			
n									10	9	14	20	34	27	10			
Dry Balearics																		
Mean									3.3	1.7	2.1	2.2	2.1	2.0	2.5	1.7	1.4	
SD									1.2	1.5	1.3	1.7	1.2	1.3	1.4	1.4	0.5	
n									8	13	41	32	35	40	48	7	5	
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean														3.3				
SD														0.6				
n														3				
S Morocco																		
Mean							1.5	1.4			1.5	1.4						
SD							0.6	0.5			0.5	0.6						
n							21	7			6	25						

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							18.0	17.1	16.9	16.5	16.7	17.1	17.2	17.7	16.6	17.4	16.9	17.4
SD							1.3	1.9	1.4	1.7	1.3	1.5	1.3	1.7	1.5	1.6	1.4	1.6
n							3	5	6	20	29	23	34	30	22	14	12	20
Columbrets																		
Mean									14.4	15.1	13.7	14.2	15.2	14.1	13.9			
SD									2.5	2.6	2.0	1.6	2.1	2.0	2.2			
n									13	13	15	20	37	28	12			
Dry Balearics																		
Mean									17.1	14.8	16.1	16.1	15.6	16.0	15.7	15.7	16.0	
SD									1.6	2.1	2.3	1.8	1.8	2.2	1.6	1.9	1.5	
n									8	13	37	30	35	38	47	7	5	
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean														16.5				
SD														1.9				
n														3				
S Morocco																		
Mean							16.0	16.7			16.0	16.8						
SD							0.9	1.1			0.7	1.5						
n							21	7			6	25						

Appendix 1. (Cont.).

Erithacus rubecula

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	54.8	55.4	55.1	54.8	54.5	54.4	54.2	54.0	53.8	53.8	54.3	53.9		55.3	56.0			
SD	1.6	1.6	1.5	1.7	1.6	1.5	1.6	1.4	1.3	1.5	1.3	2.0		0.6	1.0			
n	81	54	144	353	188	317	399	155	68	106	16	4		3	3			
Columbrets																		
Mean	55.3	54.6	55.5	54.9	55.4	55.0	53.9	53.8	53.8	53.7	53.8	53.6	53.5					
SD	1.7	0.8	1.4	1.6	1.6	1.9	1.3	1.6	1.7	1.9	1.9	1.5	0.8					
n	41	4	52	30	52	47	87	61	111	105	37	11	6					
Dry Balearics																		
Mean				54.9	54.5	54.2	54.0	53.9	53.8	53.5	53.4	53.7	53.3	54.1	53.5			
SD				1.7	1.7	1.6	1.6	1.5	1.5	1.7	1.6	1.5	1.6	1.3	1.7			
n				515	763	900	1218	1,003	1,027	475	152	86	30	8	5			
Wet Balearics																		
Mean			54.6	54.2	54.0	53.5	54.3	53.2		53.7								
SD			1.1	1.6	1.5	1.3	1.5	1.0		1.4								
n			17	31	24	11	7	5		7								
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean								52.8										
SD								1.5										
n								4										
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	1.7	1.9	2.1	2.1	2.1	2.5	2.3	2.7	2.3	2.5	2.1	2.0	2.3	1.7	1.3			
SD	1.1	1.1	1.2	1.1	1.2	1.0	1.1	1.1	1.0	1.1	1.0	1.4	0.6	1.2	1.2			
n	88	57	157	358	198	325	404	161	73	114	20	4	3	3	3			
Columbrets																		
Mean	0.8	0.0					2.0	1.8	0.7	1.3	1.4	1.4	1.3	2.6				
SD	1.1	0.0					0.6	0.7	0.9	1.1	1.2	1.2	1.1	1.4				
n	41	4					12	17	140	137	60	14	14	4				
Dry Balearics																		
Mean				2.1	1.9	2.0	2.1	2.1	2.0	2.1	2.1	2.4	1.7	2.0	1.6			
SD				1.2	1.2	1.2	1.1	1.1	1.0	1.3	1.2	1.1	1.3	1.1	1.0			
n				625	904	929	1,340	1,082	1,180	572	202	104	37	12	11			
Wet Balearics																		
Mean			1.5	2.1	2.2	2.1	2.4	2.2		3.0								
SD			0.8	0.8	0.9	1.1	0.5	0.8		1.2								
n			23	37	24	11	7	5		7								
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean								3.8										
SD								1.0										
n								4										
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	16.0	16.0	16.6	16.0	15.6	16.5	15.6	15.6	15.3	15.7	15.5	15.3	15.2	16.9	15.6			
SD	1.5	1.5	1.7	1.7	1.5	1.6	1.4	1.2	1.3	1.5	1.1	1.7	0.3	1.7	0.9			
n	88	58	156	356	198	323	399	161	72	114	19	4	3	3	3			
Columbrets																		
Mean	15.9	14.5	16.6	14.0	14.9	15.2	14.4	15.0	13.6	14.7	14.7	14.6	14.8	15.6				
SD	1.9	1.1	2.0	1.4	1.4	1.6	1.6	1.4	1.7	1.6	1.4	1.0	1.2	1.6				
n	41	4	52	33	53	63	105	58	145	139	62	13	14	4				
Dry Balearics																		
Mean				16.2	15.6	15.4	15.4	15.2	15.1	15.5	15.3	15.5	15.2	15.3	15.1			
SD				1.8	1.9	1.7	1.6	1.5	1.5	1.7	1.5	1.5	2.1	1.3	1.3			
n				610	892	918	1,318	1,068	1,074	557	187	102	37	11	10			
Wet Balearics																		
Mean			16.4	16.8	16.2	16.8	16.1	16.8		17.5								
SD			2.3	1.3	1.7	1.8	0.9	1.1		2.2								
n			23	37	24	11	7	5		6								
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean								17.8										
SD								0.9										
n								4										
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Luscinia megarhynchos

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean						66.4	65.0	65.6	65.1	64.4	63.7	63.5	63.1	62.9	63.0	63.1	63.4	63.6
SD						2.7	2.0	1.7	2.0	1.9	1.9	2.0	2.1	2.0	2.0	2.1	1.8	2.0
n						7	24	47	87	320	240	241	230	182	114	40	36	48
Columbrets																		
Mean					66.3	64.9	63.8	65.4	64.0	63.2	62.9	62.7	63.1	62.4	61.8			
SD					1.9	2.0	1.3	2.2	2.5	2.2	2.2	2.1	2.2	1.7	1.7			
n					6	8	12	14	68	224	425	241	101	63	12			
Dry Balearics																		
Mean					67.2	64.4	65.2	65.3	65.1	64.3	63.7	63.4	63.1	62.8	63.1	62.9	62.7	
SD					2.5	2.9	2.4	2.4	2.2	2.3	2.3	2.3	2.2	2.3	1.8	1.3	2.1	
n					5	4	83	148	224	428	309	312	161	152	79	5	3	
Wet Balearics																		
Mean								66.1		65.6	63.8	64.0	65.2	64.6	64.4			
SD								1.9		1.8	2.0	1.9	2.6	2.0	1.6			
n								4		19	17	22	5	8	9			
Chafarinas																		
Mean											62.8		61.1	63.0				
SD											3.1		1.9	0.9				
n											3		4	3				
N Morocco																		
Mean						65.8	63.9	63.5	63.0	63.3	62.4	62.1	62.4	62.6	62.1	62.1	59.7	
SD						0.3	1.7	2.0	1.8	1.9	1.9	1.8	2.5	2.4	3.1	1.8	1.4	
n						3	5	11	14	53	63	34	24	13	12	7	5	
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean						1.7	2.3	2.6	2.2	2.4	2.1	2.1	1.7	1.6	1.2	1.0	1.0	1.2
SD						0.8	1.5	1.3	1.3	1.3	1.3	1.2	1.3	1.2	0.8	0.9	0.9	0.8
n						7	24	49	89	326	248	251	240	192	119	41	41	51
Columbrets																		
Mean								2.3	1.4	1.6	1.8	1.7	1.4	1.6	1.5			
SD								1.0	1.4	1.1	1.2	1.3	1.0	1.1	1.0			
n								4	83	302	639	281	133	81	13			
Dry Balearics																		
Mean					1.4	3.6	2.2	2.2	2.2	2.0	2.1	2.2	2.4	2.2	2.1	2.3	1.3	
SD					1.7	1.1	1.2	1.3	1.4	1.4	1.4	1.3	1.6	1.4	1.2	0.5	1.2	
n					5	5	95	155	242	470	379	354	237	176	88	6	3	
Wet Balearics																		
Mean								2.5		2.5	2.5	2.4	1.8	2.0	1.2			
SD								0.6		1.2	1.5	1.5	1.1	0.9	0.4			
n								4		19	18	24	5	9	10			
Chafarinas																		
Mean											1.7		1.5	1.0				
SD											1.5		0.6	1.0				
n											3		4	3				
N Morocco																		
Mean						3.7	3.4	2.9	2.2	3.0	2.6	2.6	3.6	2.2	3.1	1.7	0.4	
SD						0.6	1.7	2.0	1.7	1.3	1.2	1.4	1.6	1.1	1.7	2.0	0.5	
n						3	5	11	15	59	67	37	27	17	13	7	5	
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean						19.5	19.8	20.3	20.4	20.2	20.1	20.0	19.8	19.8	19.8	20.3	20.4	20.8
SD						1.8	1.9	2.0	2.2	2.0	1.5	1.5	1.7	1.9	1.6	1.6	0.9	1.1
n						7	24	49	89	322	243	246	240	193	119	41	42	50
Columbrets																		
Mean					17.7	17.6	17.7	19.6	18.7	18.4	18.6	18.7	19.0	18.5	18.4			
SD					1.3	1.1	3.0	1.8	2.3	2.3	2.1	2.1	2.2	2.2	1.9			
n					6	8	12	13	95	314	643	286	139	85	15			
Dry Balearics																		
Mean					19.8	21.0	19.1	19.7	19.6	19.3	19.5	19.6	19.5	19.3	19.5	21.1	20.0	
SD					3.1	2.0	1.9	2.5	2.4	2.5	2.4	2.1	2.2	2.4	2.0	2.5	1.0	
n					5	5	93	153	238	464	339	347	202	175	90	6	3	
Wet Balearics																		
Mean								21.9		21.4	20.6	21.1	21.3	21.0	21.4			
SD								1.3		1.7	1.7	2.5	1.4	1.6	0.5			
n								4		19	18	24	5	9	9			
Chafarinas																		
Mean											19.7		19.6	18.6				
SD											1.0		1.6	2.3				
n											3		4	3				
N Morocco																		
Mean						22.5	21.5	21.7	20.1	21.1	19.1	20.4	21.4	19.7	20.5	18.2	19.7	
SD						1.3	3.4	2.0	3.3	2.7	2.3	2.6	2.9	2.0	2.4	3.3	0.7	
n						3	5	11	15	56	65	36	27	16	13	7	5	
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Phoenicurus phoenicurus

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean				60.7	62.6	62.4	62.0	61.9	61.8	61.8	61.6	61.5	61.2	60.9	60.7	61.7		
SD				2.5	1.6	1.6	1.7	1.6	2.0	2.1	1.6	1.7	2.2	2.0	2.0	2.4		
n				3	9	18	34	61	65	181	142	248	143	175	71	7		
Columbrets																		
Mean							61.9	61.6	61.5	61.0	61.1	60.9	61.0	61.0	60.7	61.2		
SD							1.9	1.8	2.0	2.1	2.3	2.0	1.7	1.8	1.6	1.5		
n							7	18	68	166	300	291	246	170	120	23		
Dry Balearics																		
Mean				62.1	62.0	61.3	61.7	61.7	61.5	61.1	61.1	60.9	60.7	60.8	60.5	60.6	60.6	60.4
SD				1.7	2.2	1.5	2.0	1.9	2.0	2.1	2.1	2.0	2.0	1.9	2.0	1.5	1.8	1.8
n				6	16	37	166	349	364	733	992	1,083	807	676	445	68	28	19
Wet Balearics																		
Mean										61.3	62.0	60.8	62.5					
SD										0.8	1.0	2.8	2.0					
n										3	3	3	5					
Chafarinas																		
Mean												60.9						
SD												3.1						
n												6						
N Morocco																		
Mean										59.5	60.8	60.4	61.8	61.5				
SD										2.0	1.1	2.3	0.7	1.3				
n										8	6	5	6	4				
S Morocco																		
Mean								62.0		61.6	63.5	61.4						
SD								2.1		2.1	2.9	0.9						
n								4		6	4	7						

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean				1.3	2.4	2.1	2.1	2.1	2.2	2.5	2.5	2.5	2.3	2.4	2.4	2.3		
SD				0.6	0.7	1.1	1.0	1.1	1.0	1.1	1.2	1.1	1.2	1.0	1.1	0.8		
n				3	9	18	35	62	66	190	143	260	154	180	72	7		
Columbrets																		
Mean								2.0	1.7	1.6	1.6	1.4	1.4	1.3	1.4	1.6		
SD								0.6	1.2	1.1	1.1	1.0	1.0	1.1	1.0	1.1		
n								14	79	195	364	347	307	231	115	14		
Dry Balearics																		
Mean				2.1	2.3	2.4	2.3	2.4	2.0	2.0	2.2	2.0	2.3	2.2	2.2	2.3	1.9	2.1
SD				0.9	1.1	1.2	1.0	1.0	1.0	1.1	1.2	1.1	1.2	1.1	1.1	1.2	0.8	0.9
n				7	18	38	175	365	375	825	1,108	1,221	948	768	484	84	37	27
Wet Balearics																		
Mean										3.3	2.0	3.0	3.0					
SD										0.6	1.7	1.7	1.0					
n										3	3	3	5					
Chafarinas																		
Mean												2.3						
SD												1.5						
n												6						
N Morocco																		
Mean										3.3	3.0	2.2	2.0	1.5				
SD										1.4	1.6	0.8	1.4	1.0				
n										8	6	5	6	4				
S Morocco																		
Mean								0.8		1.2	1.0	0.6						
SD								0.5		0.8	1.2	0.8						
n								4		6	4	7						

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean				12.7	14.0	14.3	14.3	14.0	14.2	14.4	14.4	14.5	14.0	14.0	14.0	14.1		
SD				0.3	1.3	1.5	1.4	1.0	1.4	1.2	1.2	1.3	1.2	1.3	1.5	1.9		
n				3	9	18	35	60	66	190	143	252	152	179	74	6		
Columbrets																		
Mean						14.0	13.4	13.9	13.7	13.6	13.6	13.5	13.8	13.5	13.9	13.5		
SD						1.3	1.7	1.8	1.4	1.4	1.8	1.4	1.6	1.7	1.3	1.1		
n						3	8	20	82	211	373	379	328	247	125	23		
Dry Balearics																		
Mean				13.4	14.5	14.0	14.0	14.3	13.8	14.0	14.1	14.1	14.2	14.1	14.0	14.4	14.3	14.4
SD				0.7	1.9	1.6	1.5	1.4	1.5	1.6	1.5	1.6	1.5	1.4	1.3	1.6	1.4	1.5
n				6	18	37	174	363	367	811	1,067	1,194	897	758	474	81	37	25
Wet Balearics																		
Mean										16.4	14.1	15.7	15.0					
SD										0.4	1.4	2.6	1.2					
n										3	3	3	5					
Chafarinas																		
Mean												15.0						
SD												2.3						
n												6						
N Morocco																		
Mean										16.2	14.9	13.8	15.4	13.2				
SD										2.4	1.8	1.0	1.6	1.1				
n										8	6	5	6	4				
S Morocco																		
Mean								13.3		13.2	12.8	12.4						
SD								1.2		1.5	1.2	1.0						
n								4		6	4	7						

Appendix 1. (Cont.).

Saxicola rubetra

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean								60.4	58.5	58.5	57.9	57.7	57.4	57.2	57.1	57.3		56.9
SD								1.7	2.4	1.6	1.7	1.6	1.8	1.8	1.6	1.2		1.6
n								4	17	62	45	62	34	75	25	5		8
Columbrets																		
Mean									57.5	57.6	58.1	56.2	56.5	56.9	56.3	57.3		
SD									1.0	1.6	1.3	2.2	2.4	2.1	2.0	0.8		
n									4	9	12	16	27	17	14	3		
Dry Balearics																		
Mean							55.2	58.8	57.5	57.4	57.3	56.9	57.0	56.6	56.5	56.1	56.6	
SD							2.8	1.7	2.4	1.9	2.0	2.0	2.0	1.8	1.9	1.8	2.2	
n							5	15	43	254	273	352	319	263	154	33	15	
Wet Balearics																		
Mean											57.5	58.3	56.7					
SD											1.3	1.0	1.8					
n											3	4	3					
Chafarinas																		
Mean													56.6					
SD													1.3					
n													6					
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean							57.3	57.0	57.0		58.5							
SD							1.8	1.0	1.4		1.5							
n							5	3	4		4							

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean								2.0	2.6	2.4	3.0	3.2	2.7	2.7	2.7	2.4		3.3
SD								2.2	1.0	1.3	1.2	1.0	1.0	1.1	1.2	0.9		0.9
n								4	17	63	46	64	35	78	25	5		8
Columbrets																		
Mean									0.0	0.7	1.1	1.5	1.5	1.5	1.7			
SD									0.0	1.1	0.9	1.4	1.1	1.5	1.8			
n									3	10	18	17	30	17	14			
Dry Balearics																		
Mean							1.4	3.4	2.7	2.4	2.5	2.4	2.6	2.7	2.6	2.8	2.3	
SD							1.1	1.3	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.4	1.3	
n							5	16	48	259	303	407	343	349	186	53	18	
Wet Balearics																		
Mean											4.0	2.8	3.0					
SD											1.0	1.0	1.0					
n											3	4	3					
Chafarinas																		
Mean													0.7					
SD													0.5					
n													6					
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean							1.0	1.0	2.5		2.0							
SD							0.0	0.0	1.7		0.8							
n							5	3	4		4							

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean								15.9	15.9	16.0	16.4	16.5	16.0	16.1	15.9	15.8		15.7
SD								0.7	1.4	1.3	1.5	1.4	1.2	1.5	1.4	1.4		0.9
n								4	17	63	46	63	34	78	25	5		8
Columbrets																		
Mean									14.0	15.2	14.5	14.8	15.8	14.7	16.0	14.0		
SD									2.0	3.3	1.8	2.1	1.9	1.9	2.2	0.6		
n									6	11	19	17	34	21	13	3		
Dry Balearics																		
Mean							13.5	16.8	15.8	15.8	16.1	16.1	16.3	15.9	15.7	16.2	16.1	
SD							1.3	2.7	1.8	2.1	2.1	1.9	2.1	1.8	1.8	1.9	1.1	
n							5	16	46	254	296	396	331	344	183	50	17	
Wet Balearics																		
Mean											17.6	16.3	14.8					
SD											1.6	2.3	0.1					
n											3	4	3					
Chafarinas																		
Mean													13.4					
SD													0.7					
n													6					
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean							13.6	13.8	14.0		14.0							
SD							1.4	1.7	2.4		1.0							
n							5	3	4		4							

Appendix 1. (Cont.).

Turdus philomelos

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	90.0	90.1	88.8	90.1	89.2	89.5	88.4	89.0	90.8	88.5	89.7							
SD	2.1	2.6	2.4	2.2	2.2	2.3	1.8	1.2	3.2	3.2	0.3							
n	38	21	25	31	33	28	26	10	6	20	3							
Columbrets																		
Mean	89.6			89.6	91.2	90.1	88.3	86.8	88.5	88.2	87.5	89.1	88.8					
SD	2.8			1.3	1.2	2.0	1.7	1.7	1.6	2.1	0.5	2.6	1.6					
n	7			5	3	4	7	6	26	13	3	4	3					
Dry Balearics																		
Mean				88.8	89.1	88.8	89.0	88.4	88.5	88.5	87.9	87.6	89.9					
SD				2.1	2.4	2.4	2.4	2.6	2.1	2.0	2.5	2.0	1.5					
n				87	39	57	53	54	33	30	8	13	4					
Wet Balearics																		
Mean			88.8							86.9								
SD			0.8							1.0								
n			3							4								
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	1.6	2.2	1.8	2.7	2.4	3.0	2.7	3.0	1.8	2.1	1.7							
SD	1.1	1.2	1.2	1.1	1.1	1.2	1.5	1.2	1.0	1.2	1.2							
n	39	21	25	31	33	28	26	10	6	20	3							
Columbrets																		
Mean	0.1							1.3	0.9	1.1	1.8	1.9	0.9					
SD	0.4							0.5	1.0	1.0	1.5	1.5	1.2					
n	7							4	33	18	5	4	4					
Dry Balearics																		
Mean				1.4	1.4	1.1	1.8	1.7	1.6	1.6	1.2	1.6	1.2					
SD				1.1	0.9	1.0	1.1	1.0	1.1	1.4	0.8	1.1	1.1					
n				91	41	58	53	56	38	38	9	14	5					
Wet Balearics																		
Mean			0.5	0.7						1.2								
SD			0.5	0.6						0.4								
n			6	3						5								
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	69.1	69.0	65.9	70.1	67.0	71.4	68.6	71.4	67.2	67.1	68.1							
SD	5.9	7.9	6.5	7.5	6.0	8.5	7.1	7.3	4.1	6.8	6.5							
n	39	21	25	31	33	27	26	10	6	20	3							
Columbrets																		
Mean	60.2			71.0	69.9	70.7	63.0	63.1	63.6	66.1	68.7		57.9					
SD	4.3			7.8	4.2	4.4	6.7	1.7	7.8	6.8	13.3		1.4					
n	6			5	3	7	8	6	20	13	5		3					
Dry Balearics																		
Mean				63.8	64.0	61.1	63.1	63.9	63.1	66.2	64.1	62.0	65.9					
SD				6.6	7.2	6.3	6.5	6.0	6.5	6.8	9.4	7.7	7.3					
n				88	40	57	52	55	36	37	9	14	5					
Wet Balearics																		
Mean			58.7							69.8								
SD			4.8							6.0								
n			6							4								
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean																		
SD																		
n																		
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Locustella naevia

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean									50.5	49.7	49.1	49.4	49.6	49.2	48.8	50.1	48.5	
SD									1.3	1.4	1.6	1.5	1.5	1.7	1.8	0.9	1.3	
n									4	22	28	87	54	80	39	6	4	
Columbrets																		
Mean											49.1	48.4	48.6	48.0	48.6			
SD											1.2	1.2	1.2	1.5	1.1			
n											19	8	16	16	10			
Dry Balearics																		
Mean								49.9	49.6	49.3	48.8	48.7	48.8	49.0	48.8			
SD								0.9	1.4	1.8	1.4	1.9	1.7	1.4	1.8			
n								5	6	13	32	52	64	64	37			
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean										50.0		47.5	49.6					
SD										1.2		1.5	2.3					
n										4		3	4					
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean									3.0	3.3	3.1	3.6	3.5	3.8	3.9	3.8	3.0	
SD									1.6	1.3	1.6	1.3	1.5	1.2	1.0	1.7	2.2	
n									4	24	29	88	56	83	39	6	4	
Columbrets																		
Mean										1.3	3.1	4.3	2.4	2.1	2.7			
SD										1.0	1.9	1.0	1.3	1.1	1.8			
n										3	21	9	16	15	10			
Dry Balearics																		
Mean								2.6	1.7	2.5	2.9	2.7	2.4	2.7	2.7			
SD								2.4	0.8	1.2	1.7	1.5	1.8	1.4	1.6			
n								5	7	13	37	59	69	66	45			
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean										3.5		2.5	4.3					
SD										1.0		0.5	1.0					
n										4		3	4					
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean									13.3	13.5	13.5	14.0	14.0	14.3	14.2	14.6	12.9	
SD									1.1	1.3	1.5	1.2	1.3	1.5	1.3	1.2	0.4	
n									4	23	29	86	55	83	39	6	4	
Columbrets																		
Mean										11.2	13.5	13.9	13.2	12.4	13.4			
SD										0.5	2.0	1.5	1.5	1.6	1.3			
n										3	18	15	16	19	10			
Dry Balearics																		
Mean								13.8	12.1	12.5	13.3	13.4	12.6	13.2	12.8			
SD								2.7	0.9	1.5	1.8	1.7	1.7	1.6	1.8			
n								5	7	13	35	58	65	65	45			
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean										13.7		12.3	14.0					
SD										1.2		1.0	1.0					
n										4		3	4					
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Acrocephalus schoenobaenus

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean		51.8		52.3	51.1	51.7	51.2	51.7	52.1	51.2	51.0	50.9	51.0	51.1	50.5	51.3	51.8	52.8
SD		2.4		1.6	1.6	2.1	1.5	1.7	1.3	1.8	1.8	1.8	2.3	2.0	1.7	1.8	2.3	1.0
n		3		5	10	15	22	22	23	131	64	80	27	33	21	4	6	4
Columbrets																		
Mean									51.5	49.3	50.3	49.9	50.8	50.0	50.2			
SD									1.8	0.6	1.4	1.4	1.8	0.0	1.5			
n									3	3	11	8	6	3	6			
Dry Balearics																		
Mean									52.0	49.8	49.7	49.5	50.6	49.9	51.4	51.8		
SD									1.1	2.1	2.5	1.9	2.0	2.2	2.6	1.9		
n									5	7	9	12	29	22	18	10		
Wet Balearics																		
Mean											52.8	52.1		51.2				
SD											0.8	2.2		2.5				
n											3	5		3				
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean						49.5	50.4	49.5	50.0	50.6	50.9	48.8	52.3	52.0				
SD						2.8	1.4	1.7	1.3	1.2	1.3	1.4	2.5	1.4				
n						3	6	13	5	8	4	6	4	6				
S Morocco																		
Mean							50.3											
SD							1.2											
n							6											

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean		0.3		2.5	3.4	3.3	3.8	3.9	3.6	3.7	4.0	3.8	4.2	3.7	3.2	2.8	4.5	1.5
SD		0.6		1.4	1.6	1.3	1.3	1.6	1.5	1.5	1.6	1.4	1.7	1.6	1.7	0.5	1.0	0.6
n		3		5	10	15	22	23	23	134	66	84	27	36	21	4	6	4
Columbrets																		
Mean									0.7	1.5	2.7	4.4	2.4	1.6	0.9			
SD									0.6	1.8	1.9	2.2	2.8	0.9	0.4			
n									3	3	11	9	7	5	5			
Dry Balearics																		
Mean							0.7		2.4	1.7	2.6	1.9	1.4	2.5	1.7	2.9	3.3	
SD							0.6		1.7	1.6	2.0	1.9	1.7	2.2	1.6	1.8	1.5	
n							3		5	7	11	16	29	26	20	12	3	
Wet Balearics																		
Mean											6.3	5.4		6.0				
SD											0.6	2.3		1.7				
n											3	5		3				
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean						1.0	2.2	2.4	1.4	4.4	4.8	3.2	1.9	2.9				
SD						0.0	0.8	1.1	0.9	1.6	1.7	0.4	1.9	2.0				
n						3	6	13	5	9	4	6	4	6				
S Morocco																		
Mean							3.6											
SD							1.0											
n							7											

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean		9.5		10.7	11.3	11.5	11.8	11.8	11.6	11.8	12.1	11.8	12.1	12.0	11.3	11.9	11.9	10.6
SD		1.0		0.7	1.4	1.3	1.1	1.3	1.3	1.3	1.4	1.1	1.1	1.3	1.4	0.6	1.7	0.3
n		3		5	10	15	20	23	23	133	64	82	27	31	20	3	6	4
Columbrets																		
Mean										10.3	11.1	12.9	11.7	10.2	9.5			
SD										1.7	2.4	2.1	2.9	0.9	0.8			
n										3	11	9	7	6	6			
Dry Balearics																		
Mean									10.2	10.4	10.9	10.9	9.9	10.7	10.5	11.5	12.4	
SD									0.8	1.8	1.8	1.8	1.6	1.9	1.4	1.1	2.1	
n									4	6	10	16	26	26	19	11	3	
Wet Balearics																		
Mean											14.3	14.1		13.8				
SD											0.8	1.1		3.5				
n											3	5		3				
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean						10.8	10.9	11.1	10.7	12.1	12.7	9.7	11.0	11.5				
SD						0.8	0.7	0.7	0.7	1.5	2.4	0.9	1.0	1.9				
n						3	6	13	5	9	4	6	4	6				
S Morocco																		
Mean							11.3											
SD							0.9											
n							7											

Appendix 1. (Cont.).

Acrocephalus scirpaceus

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							52.6	52.9	53.0	52.7	52.4	52.3	52.1	52.1	51.7	52.0	51.7	51.6
SD							1.3	1.7	2.1	1.9	2.0	1.9	1.9	1.9	1.9	1.7	1.8	1.8
n							10	39	83	418	579	1,148	998	1,728	1,940	1,169	893	668
Columbrets																		
Mean										50.7	50.9	51.6	51.9	51.8	51.5	51.7		
SD										2.3	3.1	2.3	1.8	1.7	1.7	2.4		
n										3	14	30	26	89	74	7		
Dry Balearics																		
Mean									52.8	50.8	52.4	51.9	51.7	51.9	51.6	51.0	50.7	51.1
SD									1.5	2.9	2.0	2.0	1.9	1.8	1.8	2.2	2.9	1.1
n									4	14	20	37	94	161	268	46	13	5
Wet Balearics																		
Mean											52.1	53.1	51.5	51.1	51.1			
SD											2.9	0.8	2.2	1.8	1.0			
n											4	8	7	12	5			
Chafarinas																		
Mean													51.2	51.5	50.2			
SD													1.6	2.5	1.4			
n													7	5	6			
N Morocco																		
Mean						51.2	49.6	50.9	50.7	51.3	50.6	50.2	50.6	50.9	50.6	49.9	50.5	49.3
SD						1.4	2.3	1.7	1.7	2.5	1.8	1.9	2.1	2.0	1.9	2.0	2.4	2.1
n						16	46	32	78	65	104	83	156	153	193	118	51	44
S Morocco																		
Mean							50.3	51.0	50.1	47.8	49.3	50.3						
SD							1.8	1.9	1.4	2.2	4.4	2.6						
n							38	15	6	5	4	17						

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							3.4	3.4	3.1	3.1	2.9	3.3	3.0	2.9	2.8	2.6	2.8	3.0
SD							1.0	1.5	1.5	1.5	1.4	1.3	1.4	1.4	1.3	1.2	1.2	1.4
n							11	39	83	424	579	1,147	1,048	1,770	1,962	1,177	909	682
Columbrets																		
Mean										1.7	0.9	2.0	1.0	1.7	1.3	2.3		
SD										0.6	1.0	1.6	1.1	1.2	0.9	1.3		
n										3	18	30	34	93	78	4		
Dry Balearics																		
Mean								3.0	3.0	2.9	2.6	2.4	2.2	2.6	2.6	2.9	2.9	2.4
SD								2.6	2.2	1.3	1.8	1.5	1.5	1.5	1.6	1.5	1.5	1.1
n								3	5	15	20	40	109	185	289	52	16	7
Wet Balearics																		
Mean											3.8	5.1	2.6	2.5	1.7			
SD											1.0	0.8	1.4	1.6	1.6			
n											4	8	8	15	6			
Chafarinas																		
Mean													1.6	1.0	2.4			
SD													0.8	0.9	1.5			
n													7	6	7			
N Morocco																		
Mean						1.9	2.5	3.1	3.0	2.7	2.5	2.7	2.7	2.7	2.6	2.8	2.8	2.3
SD						0.9	1.1	1.5	1.0	1.3	1.3	1.5	1.5	1.3	1.4	1.4	1.6	1.4
n						16	46	32	79	69	117	92	161	163	212	133	57	51
S Morocco																		
Mean							2.0	3.5	2.2	2.4	2.8	2.2						
SD							0.9	1.1	0.4	1.5	1.5	0.7						
n							38	15	6	5	4	17						

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							11.0	11.9	11.7	11.7	11.7	11.8	11.6	11.6	11.4	11.3	11.2	11.3
SD							1.4	1.3	1.4	1.3	1.2	1.2	1.2	1.2	1.1	1.0	0.9	1.0
n							9	39	83	421	572	1,140	1,042	1,756	1,943	1,166	892	680
Columbrets																		
Mean											9.8	10.8	10.2	10.4	10.2	11.0		
SD											1.0	1.4	1.0	1.3	0.9	1.2		
n											17	36	38	98	83	7		
Dry Balearics																		
Mean								11.7	11.1	11.1	11.4	11.3	10.8	11.1	11.0	11.7	11.3	11.3
SD								3.0	1.9	1.3	1.5	1.5	1.7	1.5	1.3	1.6	1.1	1.2
n								3	5	15	20	37	109	184	286	51	16	7
Wet Balearics																		
Mean											12.3	13.2	11.1	10.7	10.8			
SD											1.4	0.7	1.3	0.9	1.0			
n											4	8	8	15	6			
Chafarinas																		
Mean													9.4	10.5	10.3			
SD													0.7	0.9	0.9			
n													7	6	7			
N Morocco																		
Mean						10.2	10.7	10.9	11.1	11.0	10.6	11.0	10.9	10.7	10.8	10.9	10.9	10.3
SD						0.7	0.9	1.1	1.0	1.2	1.2	1.5	1.5	1.4	1.3	1.4	1.3	1.2
n						16	46	32	79	67	116	90	160	160	209	133	55	51
S Morocco																		
Mean							10.1	11.6	9.7	10.1	10.5	9.6						
SD							1.1	1.6	0.4	0.6	0.5	1.2						
n							38	15	6	5	4	17						

Appendix 1. (Cont.).

Acrocephalus arundinaceus

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							75.5	75.2	75.8	74.6	73.9	73.2	72.8	72.6	72.1	72.3	72.0	73.7
SD							2.4	1.3	2.0	2.2	2.6	2.4	2.8	2.5	2.4	2.5	2.6	2.5
n							13	7	29	113	125	142	152	214	173	47	30	29
Columbrets																		
Mean																		
SD																		
n																		
Dry Balearics																		
Mean										73.2	73.8	74.4	73.5	71.0	71.1			
SD										2.2	1.7	1.5	3.0	3.3	2.3			
n										7	4	8	10	12	14			
Wet Balearics																		
Mean										75.9	75.4	74.0	72.9	72.5	73.3			
SD										2.0	1.8	2.5	1.8	2.2	1.8			
n										4	18	14	7	11	5			
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean										73.7	74.0	71.7	72.1	72.0	70.6			
SD										2.2	2.8	1.8	2.9	2.4	1.8			
n										11	15	17	16	11	7			
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							2.2	2.8	1.9	2.3	2.4	2.6	2.4	2.3	1.9	2.7	2.4	3.0
SD							1.2	0.8	1.2	1.1	1.0	1.3	1.3	1.3	1.2	1.3	1.7	1.5
n							13	9	28	114	130	145	157	223	180	47	34	29
Columbrets																		
Mean																		
SD																		
n																		
Dry Balearics																		
Mean										1.4	1.8	1.5	3.0	2.2	2.5	2.6		
SD										1.1	1.3	1.1	1.7	1.6	1.7	1.9		
n										7	5	11	11	16	17	5		
Wet Balearics																		
Mean										2.5	3.8	3.1	2.9	4.0	2.2			
SD										1.9	1.7	1.4	1.8	1.0	2.0			
n										4	18	14	8	11	5			
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean										4.1	3.8	3.4	3.6	3.8	3.9			
SD										1.4	1.8	1.3	1.4	1.0	0.9			
n										13	17	20	17	12	7			
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Catalonia																		
Mean							29.1	30.0	29.9	29.5	29.9	30.0	29.2	29.1	28.7	29.8	29.5	30.6
SD							1.6	1.3	1.9	2.6	2.9	3.2	3.0	2.9	2.7	2.7	2.7	2.7
n							13	8	29	115	130	143	155	219	175	47	34	29
Columbrets																		
Mean																		
SD																		
n																		
Dry Balearics																		
Mean										25.5	27.9	27.6	29.7	28.9	26.4	29.3		
SD										1.9	2.5	3.4	5.4	4.9	4.2	4.9		
n										7	5	11	11	15	17	5		
Wet Balearics																		
Mean										30.5	32.3	30.4	31.6	32.5	30.8			
SD										4.8	4.7	3.3	4.4	3.9	2.4			
n										4	18	14	8	11	5			
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean										32.9	31.0	27.9	29.5	28.9	29.5			
SD										4.5	5.2	4.6	3.2	3.1	2.9			
n										13	15	20	17	12	7			
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Hippolais icterina

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean													62.2	61.9	61.2		60.8	61.6
SD													0.9	0.8	1.5		2.0	1.7
n													5	8	13		11	7
Columbrets																		
Mean														60.7	60.8	60.4		
SD														1.9	1.3	1.5		
n														12	9	4		
Dry Balearics																		
Mean												61.9	61.0	60.8	61.2	60.2	61.6	61.4
SD												1.9	1.8	2.0	1.9	1.8	2.0	1.3
n												17	52	125	157	11	10	6
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean													60.7	59.1				
SD													2.8	1.3				
n													3	6				
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean													2.8	1.8	2.3		3.4	2.4
SD													1.1	1.1	1.5		1.1	0.5
n													5	9	13		11	7
Columbrets																		
Mean												0.2	0.4	1.1	0.7	0.9		
SD												0.4	0.4	0.9	0.6	0.9		
n												9	5	17	9	4		
Dry Balearics																		
Mean											2.5	1.8	2.0	2.0	2.2	2.5	2.4	2.9
SD											1.0	1.2	1.2	1.2	1.1	1.1	1.1	0.5
n											4	19	58	154	199	26	28	11
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean													5.0	3.7				
SD													0.5	0.8				
n													3	6				
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean													12.3	12.6	12.6		13.3	13.1
SD													0.6	1.1	1.5		1.0	0.8
n													5	9	13		11	7
Columbrets																		
Mean												9.9	11.7	12.2	11.7	11.6		
SD												0.6	1.3	1.5	1.3	1.3		
n												9	8	19	9	6		
Dry Balearics																		
Mean											12.7	12.3	12.4	12.5	12.6	13.4	13.2	13.9
SD											0.8	1.4	1.3	1.4	1.3	1.2	1.4	1.1
n											4	19	57	150	196	26	28	11
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean													15.7	13.7				
SD													0.6	1.3				
n													3	6				
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Hippolais polyglotta

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean										53.0	53.0	52.3	51.5	51.5	51.3	51.1	51.0	50.6
SD										1.5	1.4	1.8	1.7	1.5	1.6	1.4	1.6	1.5
n										12	25	51	81	153	154	81	51	50
Columbrets																		
Mean										52.1	51.8	51.7	51.6	51.2	50.6	50.8		
SD										1.5	1.6	1.6	1.6	1.8	1.6	1.6		
n										20	77	65	71	130	159	12		
Dry Balearics																		
Mean										51.2	51.7	51.3	51.2	50.9	50.8	50.0	50.0	
SD										1.7	1.8	1.8	1.7	1.8	1.7	1.9	2.3	
n										15	39	66	109	305	157	29	10	
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean											50.6	50.4	50.3	50.2	49.8			
SD											1.7	1.8	1.8	1.7	1.6			
n											31	42	119	98	98			
N Morocco																		
Mean										50.3	50.8	49.5	49.8	49.9	50.0	49.8	50.6	49.3
SD										1.3	1.8	1.1	1.6	2.0	1.6	1.8	1.8	1.9
n										8	23	9	48	30	46	4	7	3
S Morocco																		
Mean							51.8											
SD							1.3											
n							3											

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean										2.6	2.5	2.6	2.3	2.4	2.1	2.0	1.8	2.2
SD										1.4	1.4	1.4	1.2	1.2	1.2	1.0	1.2	1.3
n										12	25	54	88	153	155	83	51	49
Columbrets																		
Mean										1.9	1.6	1.4	0.9	1.4	1.6	1.1		
SD										1.1	1.0	1.1	1.0	1.1	0.8	0.3		
n										20	93	76	112	151	157	9		
Dry Balearics																		
Mean										1.5	1.9	1.8	1.8	2.5	2.4	1.8	2.0	2.0
SD										0.9	1.2	1.2	1.3	1.2	1.1	1.1	1.1	0.0
n										17	42	76	125	312	163	31	12	3
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean											2.1	2.0	1.8	1.7	2.0			
SD											1.0	1.2	1.1	1.1	1.2			
n											31	43	120	101	102			
N Morocco																		
Mean										3.3	2.9	2.7	2.7	2.7	2.4	3.3	2.9	1.0
SD										1.7	1.4	1.2	1.4	1.5	1.2	0.8	1.8	0.0
n										8	23	9	51	33	50	6	8	3
S Morocco																		
Mean							2.0											
SD							1.0											
n							3											

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean										11.4	11.4	11.2	11.1	11.1	11.0	10.8	10.7	10.8
SD										1.3	0.8	0.9	0.8	1.0	0.9	0.7	0.9	0.9
n										12	24	52	87	154	155	83	51	50
Columbrets																		
Mean										10.0	10.2	10.2	10.3	10.1	10.0	10.0		
SD										0.7	1.0	1.1	0.9	1.0	0.8	0.7		
n										21	94	75	118	155	168	12		
Dry Balearics																		
Mean										10.2	10.3	10.2	10.3	10.8	10.7	10.5	10.6	10.1
SD										0.8	1.0	1.1	1.1	1.0	1.0	1.0	1.1	1.9
n										17	40	73	121	301	163	31	12	3
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean											10.7	10.5	9.7	9.9	10.1			
SD											1.3	0.9	0.8	0.8	0.8			
n											31	43	120	101	102			
N Morocco																		
Mean										10.9	10.9	10.5	10.5	10.8	10.5	10.6	11.6	10.7
SD										1.3	1.3	0.8	0.9	1.4	0.8	1.6	1.2	1.2
n										8	23	9	51	33	50	5	8	3
S Morocco																		
Mean							10.1											
SD							0.5											
n							3											

Appendix 1. (Cont.).

Sylvia cantillans & moltonii

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean			46.8	46.4	46.7	46.2	45.9	45.7	45.7	45.2	45.3	44.8	44.9	44.5	44.4			
SD			0.8	1.3	1.2	1.2	1.5	1.4	1.2	1.2	1.6	1.4	1.7	1.3	1.0			
n			3	17	15	35	80	85	112	140	53	40	48	20	13			
Columbrets																		
Mean				46.7	46.0	45.2	44.6	44.6	45.2	44.4	44.6	44.3	44.4	44	44	47		
SD				0.3	1.2	1.4	1.2	1.6	1.7	1.6	1.5	1.8	1.9	01	02	03		
n				5	6	5	37	43	59	115	130	93	36	30	16	3		
Dry Balearics																		
Mean					46.2	45.7	45.8	45.4	45.4	45.3	44.9	45.6	45.8	46	46	46	46	46
SD					1.5	2.0	1.8	1.7	1.7	2.0	1.9	1.9	1.7	1.8	1.5	1.7	1.7	1.3
n					13	31	137	284	209	255	231	246	192	240	125	31	30	10
Wet Balearics																		
Mean								46.2										
SD								1.0										
n								3										
Chafarinas																		
Mean											44.3	44.0	44.3	43.8				
SD											1.6	1.4	1.9	1.0				
n											5	4	5	5				
N Morocco																		
Mean						45.7		44.6		44.4	44.1	44.8						
SD						2.0		0.8		1.5	1.1	0.8						
n						3		4		24	16	3						
S Morocco																		
Mean							43.1											
SD							0.8											
n							4											

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean			1.7	3.4	2.8	2.9	2.7	2.8	2.8	2.8	2.7	2.7	2.5	2.8	2.8			
SD			1.5	0.9	1.5	1.4	1.2	1.3	1.3	1.4	1.2	1.2	1.1	1.3	1.6			
n			3	17	15	35	80	88	112	145	54	41	49	20	13			
Columbrets																		
Mean							2.2	1.6	1.8	1.7	1.6	1.4	1.2	0.9	1.3			
SD							1.0	1.1	1.5	1.1	1.3	1.1	1.2	0.7	0.7			
n							11	30	65	129	156	88	34	31	15			
Dry Balearics																		
Mean					2.5	2.2	2.4	2.4	2.1	2.3	2.2	2.3	2.3	2.3	2.6	2.4	2.8	2.9
SD					1.5	1.5	1.2	1.2	1.2	1.3	1.2	1.2	1.4	1.2	1.3	1.2	1.1	0.7
n					13	34	139	287	221	283	254	284	213	272	136	36	36	12
Wet Balearics																		
Mean								1.7										
SD								1.2										
n								3										
Chafarinas																		
Mean											1.2	2.5	2.8	1.4				
SD											0.4	1.7	1.8	1.5				
n											5	4	5	5				
N Morocco																		
Mean						2.3		3.0		3.7	4.0	4.5						
SD						1.2		1.4		1.5	1.6	1.2						
n						3		4		27	21	4						
S Morocco																		
Mean							3.8											
SD							0.5											
n							4											

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean			8.6	9.8	9.4	9.6	9.2	9.3	9.3	9.4	9.0	9.2	9.0	9.4	9.1			
SD			1.0	0.6	1.1	0.9	0.8	0.7	1.0	0.8	0.6	0.9	0.8	0.7	0.9			
n			3	17	15	34	80	83	111	142	54	40	48	20	13			
Columbrets																		
Mean				8.6	8..6	8.6	8.6	8.6	8.9	8.7	8.7	8.5	8.6	8.5	8.7	9.4		
SD				0.6	1.1	0.9	0.9	0.8	0.9	0.8	0.9	0.9	0.8	0.7	0.6	1.3		
n				5	7	5	39	44	67	135	157	102	38	33	17	3		
Dry Balearics																		
Mean					9.1	8.5	8.9	8.9	8.8	8.8	8.7	8.7	8.9	9.0	8.9	9.5	9.6	9.9
SD					1.1	0.8	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.1	0.8	1.3	0.9	0.6
n					12	32	136	285	214	275	247	268	206	261	132	35	35	12
Wet Balearics																		
Mean								8.9										
SD								0.5										
n								3										
Chafarinas																		
Mean											8.9	9.8	9.2	9.1				
SD											0.2	1.1	0.8	0.7				
n											5	4	5	5				
N Morocco																		
Mean						9.9		10.1		10.1	9.7	10.6						
SD						1.1		0.5		1.2	1.0	0.9						
n						3		4		26	21	4						
S Morocco																		
Mean							9.1											
SD							0.4											
n							4											

Appendix 1. (Cont.).

Sylvia communis

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean					54.5	54.9	55.2	55.9	55.7	55.4	54.9	55.2	54.9	54.9	54.6	55.4	54.7	54.4
SD					1.3	2.0	1.3	1.9	1.7	1.8	1.8	1.8	1.7	1.8	2.2	1.9	0.9	1.9
n					3	7	19	28	54	185	151	211	177	188	107	10	6	10
Columbrets																		
Mean								54.7	54.8	54.7	54.3	54.7	54.6	54.2	54.1	54.4		
SD								1.4	2.2	2.4	2.1	2.1	1.8	1.9	1.8	2.5		
n								9	28	133	309	256	204	149	121	8		
Dry Balearics																		
Mean						54.6	55.2	55.3	54.9	54.6	54.6	54.6	54.8	54.6	54.6	54.0	54.9	54.8
SD						1.0	2.7	1.9	1.9	2.1	2.1	2.0	2.1	2.0	2.0	1.8	1.6	2.1
n						7	51	171	178	663	679	963	959	894	662	127	45	43
Wet Balearics																		
Mean								55.1			54.9	55.6						
SD								1.1			2.4	2.5						
n								4			7	11						
Chafarinas																		
Mean											52.8	52.7	53.6	52.8	53.3			
SD											0.3	1.0	1.5	2.0	0.8			
n											3	9	17	6	6			
N Morocco																		
Mean										54.7	54.2	54.1	54.6	54.7	53.9			
SD										1.3	1.9	1.4	1.7	1.7	1.5			
n										10	10	5	4	10	9			
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean					3.6	3.4	3.3	2.7	2.7	3.0	3.2	3.3	3.1	2.7	2.9	3.9	3.8	2.5
SD					0.8	1.3	1.7	1.5	1.2	1.3	1.4	1.4	1.4	1.3	1.1	1.4	1.7	1.4
n					3	7	19	28	56	189	156	222	181	192	110	10	6	10
Columbrets																		
Mean								3.0	1.4	2.3	2.0	1.9	1.8	1.4	1.7	1.6		
SD								2.2	1.5	1.4	1.4	1.5	1.3	1.1	1.1	0.8		
n								6	33	151	351	319	242	190	114	7		
Dry Balearics																		
Mean						2.4	2.3	2.4	2.1	2.3	2.5	2.5	2.7	2.4	2.7	2.2	2.6	2.6
SD						1.7	1.3	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.2	1.2
n						7	54	175	195	703	774	1,089	1,055	1,091	751	180	59	59
Wet Balearics																		
Mean								1.8			4.0	3.5						
SD								0.5			1.2	1.9						
n								4			7	11						
Chafarinas																		
Mean											0.3	1.6	1.1	0.4	1.7			
SD											0.6	1.6	0.6	0.5	1.0			
n											3	10	17	7	6			
N Morocco																		
Mean										3.2	3.1	3.2	5.3	4.1	3.8			
SD										1.6	2.0	2.4	1.0	1.4	1.7			
n										10	11	5	4	10	11			
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean					14.3	15.3	14.4	14.3	13.8	14.4	14.4	14.6	14.5	14.3	14.1	15.2	14.8	13.5
SD					0.6	1.2	1.7	1.4	1.3	1.6	1.7	1.5	1.6	1.5	1.3	1.7	1.6	0.8
n					3	6	19	28	55	185	156	209	182	189	111	9	6	10
Columbrets																		
Mean								13.4	13.6	13.7	13.7	13.8	13.8	13.0	13.1	13.5		
SD								1.9	2.1	1.7	1.9	1.9	1.8	1.5	1.2	1.2		
n								7	49	159	362	342	251	206	132	9		
Dry Balearics																		
Mean						12.8	13.3	13.4	13.4	13.7	13.8	13.9	14.3	13.8	13.9	13.8	14.3	14.3
SD						0.8	1.6	1.7	1.5	1.8	1.8	1.7	1.8	1.7	1.6	1.6	1.6	1.4
n						7	54	173	192	687	757	1,056	1,032	1,070	731	181	57	59
Wet Balearics																		
Mean								13.3			15.4	15.7						
SD								0.7			2.1	3.8						
n								4			7	11						
Chafarinas																		
Mean											13.0	13.7	12.4	13.0	12.6			
SD											1.2	2.2	1.0	1.4	1.3			
n											3	10	17	7	6			
N Morocco																		
Mean										14.6	14.0	14.7	17.0	15.2	14.2			
SD										1.3	1.7	2.2	0.3	1.8	1.0			
n										10	11	5	4	10	11			
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Sylvia borin

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean									59.6	60.2	60.1	60.3	60.5	60.6	60.4	61.4	61.1	61.4
SD									1.3	1.5	2.1	1.9	2.2	2.0	2.0	1.9	2.0	1.8
n									14	43	92	196	294	347	355	81	44	38
Columbrets																		
Mean									60.4	58.5	59.9	60.0	60.2	60.1	60.2	61.0		
SD									1.9	2.4	2.1	2.0	1.9	2.1	1.9	1.7		
n									4	66	121	160	266	232	171	15		
Dry Balearics																		
Mean							60.4	59.9	59.5	60.1	59.6	59.9	60.4	60.2	60.2	60.2	60.2	61.1
SD							2.1	1.1	2.1	2.1	2.2	2.2	2.2	2.0	2.0	1.9	1.9	2.3
n							11	14	58	237	268	513	842	1,088	1,460	353	154	57
Wet Balearics																		
Mean											62.2	60.0	61.4	61.3	61.9			
SD											2.4	2.2	1.7	1.6	1.5			
n											10	14	7	9	10			
Chafarinas																		
Mean											57.7	58.9	58.6	59.4	59.3			
SD											2.0	1.5	2.3	1.9	2.5			
n											3	5	21	11	6			
N Morocco																		
Mean								59.8	60.3	59.3	59.3	59.6	59.6	59.7	59.6	59.5	59.2	58.8
SD								1.1	1.9	1.5	2.1	2.3	1.9	1.9	1.8	2.0	1.8	2.0
n								7	24	39	57	36	82	105	71	49	15	6
S Morocco																		
Mean							59.5											
SD							1.0											
n							6											

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean									1.6	2.2	2.3	2.4	2.7	2.6	2.6	2.6	2.9	2.9
SD									1.3	1.2	1.5	1.4	1.4	1.3	1.3	1.1	1.2	1.1
n									14	43	92	211	307	354	364	81	44	40
Columbrets																		
Mean									1.1	2.1	1.8	1.5	1.5	1.5	1.6	2.5		
SD									0.9	1.1	1.2	1.2	1.3	1.2	1.3	2.5		
n									7	79	161	177	311	304	180	10		
Dry Balearics																		
Mean							1.8	2.7	2.3	1.9	1.9	2.0	2.1	2.1	2.2	2.5	2.5	2.5
SD							1.1	1.4	1.1	1.0	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.3
n							13	15	63	245	288	564	888	1,242	1,555	511	217	93
Wet Balearics																		
Mean											3.3	2.1	3.4	2.9	3.7			
SD											1.3	1.0	1.1	1.7	0.8			
n											10	14	7	10	10			
Chafarinas																		
Mean											4.0	3.8	2.8	3.3	1.2			
SD											2.0	0.8	1.4	1.1	0.8			
n											3	5	22	12	6			
N Morocco																		
Mean								3.4	4.2	3.9	3.8	4.3	3.4	3.2	3.3	3.9	4.8	5.8
SD								1.0	1.1	1.0	1.2	1.2	1.5	1.3	1.6	1.2	1.1	0.8
n								7	24	41	58	36	95	129	84	55	15	6
S Morocco																		
Mean							2.5											
SD							0.5											
n							6											

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean									15.3	16.0	16.8	17.0	17.2	17.4	17.2	17.9	17.9	18.2
SD									1.4	1.7	2.1	1.8	2.1	1.9	2.0	1.5	1.5	1.7
n									14	43	92	196	305	353	365	81	44	37
Columbrets																		
Mean									15.0	15.3	15.8	15.7	15.9	15.8	15.6	17.0		
SD									1.0	1.8	2.0	1.9	2.1	1.9	2.1	3.5		
n									13	85	163	185	321	315	198	15		
Dry Balearics																		
Mean							15.3	15.4	15.5	15.2	15.7	16.2	16.4	16.6	16.5	17.4	17.8	17.2
SD							2.2	1.2	1.4	1.5	2.0	2.0	2.1	2.2	2.1	2.2	2.3	2.0
n							13	15	63	244	286	554	880	1,219	1,538	503	213	93
Wet Balearics																		
Mean											18.8	16.1	18.9	19.3	18.9			
SD											2.6	1.4	2.9	2.7	1.9			
n											10	14	7	10	10			
Chafarinas																		
Mean											17.8	16.2	16.2	17.5	15.1			
SD											1.2	0.9	1.7	1.9	1.1			
n											3	5	22	12	6			
N Morocco																		
Mean								16.8	19.9	17.6	17.8	18.6	17.6	17.4	17.7	18.0	18.5	19.8
SD								1.6	3.1	1.7	2.2	3.3	2.0	1.9	2.1	2.2	2.0	0.9
n								7	24	41	59	35	95	125	81	46	13	6
S Morocco																		
Mean							15.5											
SD							0.8											
n							6											

Appendix 1. (Cont.).

Sylvia atricapilla

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	56.6	56.7	56.5	56.6	57.1	56.7	56.7	56.9	56.8	56.3	56.2	56.3	56.1	56.4	56.0	56.5	55.0	
SD	1.9	1.8	1.6	1.7	1.9	1.7	1.8	1.8	1.7	1.9	2.0	1.7	2.1	1.5	1.6	1.4	1.4	
n	50	64	62	133	217	264	569	603	675	855	328	243	70	50	27	8	4	
Columbrets																		
Mean	56.8	57.7	57.0	57.6	57.5	57.8	56.2	56.6	56.5	56.3	56.3	56.4	55.5	56.8	56.7			
SD	1.9	0.6	0.9	1.7	1.2	1.9	2.0	1.7	2.2	1.7	2.3	2.5	1.6	1.7	6.5			
n	3	3	4	10	10	6	22	52	85	162	113	42	21	6	3			
Dry Balearics																		
Mean				56.7	56.7	56.5	56.4	56.6	56.4	55.9	56.0	55.8	55.8	55.8	55.8	55.9	56.8	
SD				1.9	1.7	2.0	2.2	1.8	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.5	1.7	
n				96	149	184	456	687	579	672	568	492	259	143	73	13	8	
Wet Balearics																		
Mean			58.0	58.3	57.1	59.2	57.4	57.0		56.3	56.4	55.3	56.1	56.2				
SD			1.3	1.1	2.1	2.9	1.5	2.1		2.0	1.5	1.3	0.9	1.7				
n			3	8	9	3	8	20		62	20	8	5	7				
Chafarinas																		
Mean														55.7				
SD														0.3				
n														3				
N Morocco																		
Mean						56.5	57.1	56.5	56.6	56.5	57.3	55.8	55.3	57.0		54.9		
SD						1.6	1.7	1.5	1.5	1.7	1.4	2.3	2.4	2.0		2.0		
n						75	54	26	36	26	23	23	12	3		4		
S Morocco																		
Mean							56.6		56.6	56.3	56.3	56.3						
SD							1.7		1.8	2.1	0.6	2.5						
n							14		5	4	3	3						

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	2.6	3.2	2.7	2.9	3.7	3.5	3.1	3.2	2.7	2.8	2.7	2.8	2.3	2.3	2.8	2.9	2.5	
SD	1.5	1.5	1.6	1.6	1.8	1.7	1.6	1.6	1.5	1.6	1.6	1.4	1.3	1.5	1.3	1.4	1.7	
n	52	68	68	124	222	266	573	614	711	866	332	248	75	54	27	8	4	
Columbrets																		
Mean	1.3	2.0					3.6	3.2	2.7	2.9	2.7	2.3	2.1	2.2	1.6			
SD	0.6	2.0					1.7	1.4	1.7	1.8	1.7	1.6	1.6	1.7	1.6			
n	3	3					10	46	107	190	144	65	33	8	4			
Dry Balearics																		
Mean				3.5	3.7	3.4	3.7	3.7	3.3	3.2	3.2	2.9	2.6	2.9	2.8	1.7	3.3	
SD				1.5	1.7	1.6	1.7	1.7	1.8	1.8	1.7	1.7	1.7	1.6	1.5	1.4	1.6	
n				126	161	190	469	702	608	765	596	552	276	160	76	19	8	
Wet Balearics																		
Mean			3.3	4.6	3.3	2.3	2.3	3.6		3.4	3.3	3.0	2.2	3.0				
SD			1.5	1.1	1.8	1.5	1.5	1.3		1.4	1.6	1.5	0.8	2.1				
n			3	8	10	3	8	20		62	22	8	5	7				
Chafarinas																		
Mean														2.7				
SD														2.5				
n														3				
N Morocco																		
Mean						3.7	2.3	2.0	4.2	4.7	4.3	2.7	4.2	3.3		3.3		
SD						1.6	1.6	1.6	1.4	1.5	1.8	2.0	2.2	2.2		0.5		
n						77	54	26	38	26	23	25	16	4		4		
S Morocco																		
Mean							2.5		3.6	3.8	2.3	2.7						
SD							1.4		1.5	1.3	1.2	1.5						
n							15		5	4	3	3						

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	17.4	18.3	18.0	18.0	18.7	18.6	18.1	18.0	17.4	17.5	17.6	17.4	16.9	17.2	17.9	17.6	17.3	
SD	1.4	1.7	2.2	1.7	2.3	2.4	2.2	2.1	1.9	2.2	2.0	1.8	1.5	1.8	1.4	0.9	0.8	
n	52	68	68	123	222	266	548	606	704	855	327	248	76	54	27	8	4	
Columbrets																		
Mean	15.9	17.0	20.7	19.6	17.6	16.6	17.4	17.8	16.9	17.6	17.7	17.2	17.6	17.0	15.2			
SD	1.1	2.6	2.1	3.2	2.7	2.3	2.9	2.5	2.5	2.4	2.7	2.2	2.5	3.1	1.5			
n	3	3	4	10	11	6	20	55	108	193	148	67	33	9	4			
Dry Balearics																		
Mean				18.9	18.9	18.3	18.6	18.1	17.7	18.0	17.8	17.3	17.0	17.3	17.1	16.2	18.3	
SD				2.5	2.9	2.6	2.9	2.9	2.6	2.8	2.5	2.2	2.1	2.2	1.8	1.4	1.7	
n				124	156	185	452	692	594	748	582	535	271	154	76	19	8	
Wet Balearics																		
Mean			20.2	21.2	18.9	17.6	17.4	19.2		18.2	18.2	17.2	17.3	18.9				
SD			3.0	1.5	2.4	2.3	1.4	1.9		1.8	2.3	1.9	1.3	2.3				
n			3	7	9	3	8	20		62	22	8	4	7				
Chafarinas																		
Mean														17.6				
SD														1.2				
n														3				
N Morocco																		
Mean						20.5	18.7	18.6	20.2	20.4	20.0	19.4	19.2	18.6		16.0		
SD						2.9	2.0	2.1	2.5	2.9	2.6	2.5	2.1	2.0		1.4		
n						77	54	26	38	25	23	24	16	3		4		
S Morocco																		
Mean							17.4		17.8	18.3	17.0	16.7						
SD							1.2		2.0	1.7	0.4	0.8						
n							15		5	4	3	3						

Appendix 1. (Cont.).

Phylloscopus bonelli

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							51.0	51.0	49.9	49.4	49.1	48.2	49.8	48.3	48.3			
SD							1.5	2.1	2.3	2.5	2.3	2.6	2.4	1.9	1.7			
n							3	10	13	24	31	18	13	14	13			
Columbrets																		
Mean							49.4		50.5	48.3	49.2	48.3	48.3	48.6	48.2			
SD							2.7		1.3	2.4	2.8	2.2	1.9	2.3	2.2			
n							6		3	24	53	52	28	26	23			
Dry Balearics																		
Mean							51.0	50.0	49.5	49.1	48.5	47.8	48.0	48.1	47.7	47.6		
SD							1.4	2.5	1.9	2.3	2.3	2.2	2.2	1.8	1.9	3.0		
n							7	23	24	88	162	133	111	92	59	4		
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean															44.8			
SD															0.3			
n															3			
N Morocco																		
Mean											47.2		45.3					
SD											0.8		1.5					
n											3		3					
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							1.5	2.9	3.0	2.6	2.1	2.3	2.1	2.3	2.3			
SD							0.5	0.9	1.6	1.1	1.4	1.2	1.3	1.0	1.3			
n							3	10	13	24	31	19	13	15	13			
Columbrets																		
Mean								0.7	2.3	1.1	1.1	0.8	0.7	0.5	1.1			
SD								0.6	1.5	1.2	0.9	0.7	0.6	0.7	1.0			
n								3	4	24	60	55	31	33	16			
Dry Balearics																		
Mean							2.1	1.9	1.6	2.1	2.0	2.1	2.4	2.2	2.3	1.2		
SD							1.2	1.0	1.1	1.0	1.0	1.1	1.2	1.3	0.9	1.1		
n							7	26	26	93	173	139	118	97	66	5		
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean											2.0				1.0			
SD											1.0				1.0			
n											3				3			
N Morocco																		
Mean											2.3			1.3				
SD											2.1			1.5				
n											3			3				
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							7.1	7.5	7.6	7.4	7.1	7.2	7.2	7.3	7.2			
SD							0.2	0.7	0.7	0.7	0.8	0.8	0.7	1.0	0.8			
n							3	10	13	24	31	18	13	15	13			
Columbrets																		
Mean							7.3	6.1	7.7	6.8	6.8	6.5	6.4	6.6	6.4			
SD							0.9	0.7	1.0	0.7	0.9	0.7	0.6	0.9	0.6			
n							6	3	7	29	61	59	34	34	24			
Dry Balearics																		
Mean							7.0	7.2	7.0	7.4	7.1	7.0	7.2	7.2	7.1	7.1		
SD							0.9	0.9	0.8	0.9	0.8	0.7	0.7	0.8	0.7	0.9		
n							7	25	25	92	171	136	114	96	65	5		
Wet Balearics																		
Mean																		
SD																		
n																		
Chafarinas																		
Mean											7.1				6.6			
SD											1.0				0.6			
n											3				3			
N Morocco																		
Mean													6.8					
SD													0.4					
n													3					
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Phylloscopus sibilatrix

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							60.8	60.7	60.5	60.4	60.6	59.8	58.0	58.7	58.4			
SD							1.5	1.9	1.7	1.6	1.7	2.1	1.9	2.2	2.5			
n							3	6	19	35	21	36	33	23	10			
Columbrets																		
Mean									58.4	60.5	60.1	59.0	56.6	58.2	57.9			
SD									2.7	2.0	3.1	2.1	2.0	3.7	3.1			
n									4	13	7	62	15	9	13			
Dry Balearics																		
Mean							61.2	61.0	60.0	59.3	58.8	58.6	57.9	57.7	57.4	57.5	58.5	
SD							1.0	1.4	1.7	2.1	2.4	2.3	2.3	2.1	1.9	1.4	1.1	
n							14	13	19	73	80	135	95	135	66	10	4	
Wet Balearics																		
Mean								60.3		60.2	59.9	59.8	59.4					
SD								1.3		1.9	2.6	1.6	1.6					
n								3		6	12	13	6					
Chafarinas																		
Mean										59.6	59.0							
SD										2.5	1.0							
n										4	3							
N Morocco																		
Mean										59.5	59.7		59.4	58.2				
SD										1.8	1.2		2.2	3.2				
n										21	6		10	5				
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							1.3	2.0	2.2	1.9	2.2	2.1	2.4	2.6	2.4			
SD							1.5	1.4	1.5	1.2	1.2	1.2	1.1	1.6	1.7			
n							3	6	19	35	22	37	34	26	10			
Columbrets																		
Mean									0.6	0.5	0.6	0.8	0.9	0.9	0.6			
SD									0.9	0.7	0.5	0.9	1.3	0.9	0.6			
n									4	13	8	78	17	13	15			
Dry Balearics																		
Mean							1.2	2.1	1.9	1.5	2.1	1.7	1.7	1.9	2.3	2.6	1.9	
SD							0.8	1.4	1.2	1.0	1.1	1.1	1.2	1.2	1.1	1.1	1.0	
n							16	13	20	82	93	168	112	174	89	20	8	
Wet Balearics																		
Mean								2.0		2.1	3.2	1.9	2.2					
SD								0.0		1.3	1.2	1.3	0.8					
n								3		7	12	15	5					
Chafarinas																		
Mean										2.3	1.7							
SD										1.3	1.2							
n										4	3							
N Morocco																		
Mean										2.9	2.5		3.1	2.5				
SD										1.6	1.4		1.1	0.6				
n										23	6		10	6				
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							8.3	8.7	9.0	8.9	9.6	9.2	9.3	9.5	9.4			
SD							0.6	0.9	0.9	0.9	1.2	0.9	0.9	1.3	1.5			
n							3	6	19	35	22	37	34	26	10			
Columbrets																		
Mean									8.3	7.8	8.1	8.1	8.0	8.3	8.3			
SD									0.6	0.8	1.5	0.7	0.8	0.9	0.9			
n									4	13	9	74	20	13	14			
Dry Balearics																		
Mean							8.1	9.7	9.0	8.6	9.1	8.9	8.8	8.9	9.2	9.9	9.4	
SD							0.7	1.3	1.1	1.1	1.2	1.2	1.1	1.1	1.0	1.5	0.9	
n							15	13	20	80	91	167	108	166	85	19	8	
Wet Balearics																		
Mean								8.9		9.4	10.4	8.8	9.2					
SD								0.8		0.9	1.3	1.2	0.5					
n								3		6	12	15	6					
Chafarinas																		
Mean										10.0	8.9							
SD										0.3	0.8							
n										4	3							
N Morocco																		
Mean										9.8	9.7		9.6	9.1				
SD										1.0	2.2		0.7	0.8				
n										22	6		10	6				
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Phylloscopus collybita

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	46.5	47.1	46.2	44.7	44.2	44.0	43.6	43.8	43.8	43.8	43.9	44.7	44.5	44.6	43.1		45.0	
SD	2.2	1.9	2.4	2.5	2.2	2.4	1.8	1.9	2.1	2.4	2.4	2.6	2.7	2.5	1.7		1.6	
n	316	284	236	316	262	269	161	70	69	89	32	37	17	12	11		4	
Columbrets																		
Mean	47.4	46.0	47.1	45.9	44.6	43.9	43.5	43.7	43.4	44.2	44.1	44.1	43.8	44.4	44.9	44.2		
SD	1.8	2.9	2.4	2.9	2.5	2.4	2.4	2.3	2.4	2.9	2.7	2.7	2.8	3.2	2.9	2.8		
n	82	12	78	38	102	34	38	39	107	115	79	59	29	34	20	3		
Dry Balearics																		
Mean				45.5	44.2	43.2	43.4	43.4	43.7	43.7	44.0	43.8	44.2	43.4	44.2	44.2	44.0	
SD				2.5	2.6	2.2	2.0	2.2	2.2	2.2	2.7	2.6	2.6	2.5	2.6	3.1	1.8	
n				343	501	353	675	629	223	183	136	91	59	61	52	7	4	
Wet Balearics																		
Mean			45.4	45.3	43.3	43.6	43.1	43.6		45.8								
SD			2.4	2.3	1.8	1.5	2.6	1.9		0.5								
n			48	27	14	14	15	14		4								
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean						45.2	43.3	44.8	44.4		43.4	43.6		46.2				
SD						1.9	2.5	2.8	4.1		2.1	2.6		2.4				
n						7	29	10	4		20	8		6				
S Morocco																		
Mean									43.3	43.5	44.3							
SD									1.1	2.1	2.8							
n									7	23	11							

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean	2.7	2.7	2.6	2.8	2.8	2.9	2.9	3.2	2.7	2.7	2.5	2.4	2.1	1.7	2.2		1.8	
SD	1.1	1.0	1.1	1.1	1.2	1.2	1.2	1.2	1.1	1.2	1.2	1.3	1.5	1.2	1.0		1.7	
n	333	307	258	325	276	276	167	72	69	92	33	37	18	12	11		4	
Columbrets																		
Mean	0.8	0.6	1.8				1.7	2.1	1.5	1.3	1.5	1.0	0.8	1.2	0.9	1.0		
SD	1.0	0.9	1.1				0.5	0.9	1.2	1.2	1.3	0.9	0.6	1.0	0.7	0.8		
n	82	12	13				7	11	123	141	91	74	43	39	21	4		
Dry Balearics																		
Mean				2.1	2.8	2.5	2.8	2.8	2.7	2.5	2.0	2.1	2.1	1.8	1.8	1.5	1.3	
SD				1.2	1.3	1.3	1.2	1.1	1.1	1.3	1.2	1.3	1.5	1.5	1.1	0.8	0.8	
n				379	519	362	724	666	258	211	155	110	76	73	58	11	6	
Wet Balearics																		
Mean			1.9	2.2	2.5	2.8	2.3	3.3		3.2								
SD			0.9	0.9	1.2	1.3	1.0	1.4		0.8								
n			53	31	14	14	15	16		5								
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean						1.7	2.3	3.4	3.3		3.3	2.5		1.7				
SD						1.1	1.4	1.5	2.1		1.3	1.2		0.5				
n						7	29	10	4		20	8		6				
S Morocco																		
Mean									1.9	3.3	2.9							
SD									0.7	1.4	1.7							
n									7	23	11							

Body mass

	March						April						May					
	13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Catalonia																		
Mean	7.7	7.8	7.7	7.5	7.3	7.3	7.2	7.1	7.2	7.1	7.4	7.5	7.4	7.3	7.2		7.3	
SD	0.8	0.7	0.9	0.9	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.9	1.0	0.6		1.0	
n	334	302	255	324	273	273	160	70	67	92	32	37	18	12	11		4	
Columbrets																		
Mean	7.3	6.8	7.5	7.2	7.1	7.0	6.6	7.1	6.6	6.9	6.9	6.9	6.7	6.8	6.9	6.6		
SD	0.7	0.8	0.8	1.0	0.8	0.7	0.7	0.8	0.8	0.9	0.9	0.7	0.6	0.8	0.8	0.9		
n	82	12	76	36	100	49	53	39	121	142	90	79	45	42	23	6		
Dry Balearics																		
Mean				7.3	7.1	6.8	7.0	7.0	7.2	7.2	7.0	7.0	7.3	6.8	7.2	7.3	6.9	
SD				0.9	0.9	0.9	0.8	0.7	0.8	0.8	0.8	0.9	1.2	0.9	0.7	0.9	0.7	
n				354	506	347	710	651	233	205	149	106	73	72	57	10	6	
Wet Balearics																		
Mean			7.4	7.6	7.2	7.4	7.3	8.0		8.5								
SD			0.8	0.9	0.8	0.6	0.8	0.7		0.6								
n			53	30	14	14	15	16		5								
Chafarinas																		
Mean																		
SD																		
n																		
N Morocco																		
Mean						7.9	7.2	8.1	8.7		7.7	7.6		7.9				
SD						0.8	0.6	0.8	1.5		1.4	0.5		0.9				
n						7	27	9	4		19	8		6				
S Morocco																		
Mean									7.0	7.8	7.7							
SD									0.5	1.3	1.4							
n									6	23	10							

Appendix 1. (Cont.).

Phylloscopus trochilus

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean			53.8	53.9	53.7	53.6	53.5	53.1	53.0	52.1	52.0	51.4	50.4	50.1	50.1	50.2	49.7	50.5
SD			2.1	1.1	1.4	1.6	1.9	2.2	2.2	2.7	2.6	2.6	2.3	2.0	1.9	1.6	0.6	2.4
n			7	51	189	361	524	623	900	1,657	1,060	1,530	881	757	293	18	3	8
Columbrets																		
Mean					55.0	53.2	51.2	51.6	52.0	51.8	51.3	50.6	49.9	49.7	49.5	50.2	50.0	
SD					1.3	2.9	3.2	3.0	2.7	2.8	2.8	2.5	2.3	2.0	1.8	1.4	0.0	
n					24	23	58	167	304	945	1,363	1,343	1,130	773	583	38	3	
Dry Balearics																		
Mean				53.4	53.3	53.0	53.2	52.7	52.1	51.8	51.4	50.6	50.1	49.8	49.7	49.3	49.4	
SD				1.4	2.0	1.8	1.9	2.3	2.6	2.6	2.7	2.6	2.3	2.1	1.8	2.0	2.1	
n				19	75	260	1,283	2,359	2,007	4,152	3,533	4,740	3,723	2,703	1,941	112	44	
Wet Balearics																		
Mean			53.4	52.4	53.3	54.5	53.7	53.7		53.1	53.1	51.1	51.1	51.7	48.7			
SD			0.5	0.5	0.8	1.0	1.1	1.7		2.3	2.5	2.3	2.7	2.5	2.3			
n			4	5	3	11	14	110		55	91	38	21	8	3			
Chafarinas																		
Mean										52.0	49.8	49.5	49.1	48.7	49.0			
SD										2.5	2.4	1.7	2.0	1.3	1.9			
n										13	31	87	50	58	25			
N Morocco																		
Mean						51.3	50.4	51.2	51.6	50.9	50.4	51.1	49.8	49.6	49.9	47.6	48.8	
SD						2.2	2.1	2.3	2.2	2.9	2.6	2.7	2.7	2.1	1.9	0.9	1.8	
n						37	8	23	59	127	98	67	40	42	16	6	3	
S Morocco																		
Mean							51.9	51.7	51.5	49.8	51.1	50.0						
SD							2.3	2.9	3.6	0.3	2.1	1.7						
n							34	23	9	4	20	3						

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean			2.4	2.7	3.0	2.9	2.6	2.9	2.8	2.9	3.1	3.4	3.3	3.2	3.2	3.2	4.3	3.5
SD			1.2	1.1	1.1	1.1	1.2	1.1	1.1	1.2	1.2	1.1	1.1	1.1	1.1	1.3	0.6	0.8
n			7	51	190	365	529	641	906	1,701	1,077	1,554	908	772	301	18	3	8
Columbrets																		
Mean							2.5	2.6	2.5	1.9	1.8	1.8	1.6	1.7	1.5	1.8		
SD							0.9	1.0	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2		
n							23	152	325	1,134	1,518	1,468	1,234	858	541	12		
Dry Balearics																		
Mean				2.1	2.7	2.8	3.2	3.1	2.9	2.9	3.0	2.9	3.2	2.9	3.1	2.6	2.1	
SD				1.2	1.3	1.3	1.1	1.1	1.1	1.2	1.4	1.3	1.5	1.2	1.2	1.3	1.1	
n				22	74	267	1,311	2,507	2,104	4,398	4,116	5,431	4,401	2,920	2,020	137	50	
Wet Balearics																		
Mean			2.5	2.8	1.7	2.5	2.6	2.3		2.9	3.1	3.3	3.1	2.8	2.5			
SD			0.6	1.3	1.2	1.2	0.8	0.9		1.2	1.0	1.2	1.3	1.2	1.7			
n			4	5	3	11	14	110		56	95	38	21	8	4			
Chafarinas																		
Mean										1.6	1.9	1.8	1.8	1.2	1.6			
SD										1.1	1.3	1.0	1.2	1.0	1.0			
n										13	31	87	52	60	25			
N Morocco																		
Mean						1.9	2.6	2.4	2.9	3.0	2.5	2.9	3.1	2.1	3.3	3.8	3.3	
SD						1.1	1.9	0.9	1.1	1.4	1.5	1.4	1.7	1.3	1.1	2.4	2.1	
n						37	8	24	60	132	108	71	42	43	21	6	3	
S Morocco																		
Mean							3.4	3.2	3.2	4.0	3.0	2.7						
SD							1.3	1.2	1.2	1.2	1.5	1.2						
n							32	23	9	4	20	3						

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean			9.2	9.0	9.1	9.0	8.8	8.8	8.8	8.7	8.7	8.8	8.4	8.3	8.4	8.5	7.9	8.1
SD			1.2	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.0	0.9	0.9	0.8	0.7	0.3	0.8
n			7	51	187	361	501	640	904	1,665	1,071	1539	907	763	301	18	3	8
Columbrets																		
Mean					8.7	9.3	8.7	8.9	8.6	8.5	8.5	8.2	7.9	7.6	7.6	8.0		
SD					1.0	0.8	1.3	1.2	1.1	1.1	1.1	1.1	1.0	0.9	0.8	0.8		
n					24	24	64	167	372	1,306	1,550	1,844	1,397	946	622	39		
Dry Balearics																		
Mean				8.7	9.2	9.0	9.3	9.2	8.9	8.8	8.7	8.5	8.3	8.3	8.2	8.1	8.0	
SD				0.9	1.0	1.1	1.1	1.1	1.1	1.1	1.0	1.1	1.0	0.9	0.8	0.9	0.9	
n				22	74	262	1,293	2,450	2,047	4,361	3,784	5,098	4,009	2,935	2,025	135	50	
Wet Balearics																		
Mean			9.3	9.0	8.5	9.2	9.3	9.0		9.1	9.1	8.9	8.9	9.0	7.9			
SD			0.6	1.2	0.8	1.0	0.9	0.9		1.0	0.9	1.2	1.0	0.7	0.8			
n			4	5	3	11	14	111		54	94	37	20	7	4			
Chafarinas																		
Mean										8.2	8.1	7.4	7.4	7.1	7.2			
SD										1.0	1.1	0.8	1.0	0.7	0.5			
n										13	30	87	52	59	25			
N Morocco																		
Mean						9.0	9.4	8.3	9.3	8.9	8.6	8.7	8.8	8.3	8.4	8.2	9.5	
SD						0.9	1.7	0.7	1.0	1.3	1.2	1.2	1.2	1.3	0.7	1.1	0.9	
n						37	8	24	60	129	107	66	42	42	20	6	3	
S Morocco																		
Mean							9.2	9.3	9.6	9.9	9.8	9.5						
SD							1.1	1.5	2.3	0.3	1.1	0.6						
n							33	23	9	4	20	3						

Appendix 1. (Cont.).

Muscicapa striata

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean									68.1	67.3	66.5	68.5	67.4	67.5	66.7	68.1	66.8	67.8
SD									1.4	1.2	2.3	1.9	1.8	2.0	2.2	2.2	3.3	1.7
n									4	4	11	23	57	77	67	7	3	4
Columbrets																		
Mean										64.0	65.4	64.9	63.8	64.8	65.4	65.9		
SD										3.3	2.9	2.9	2.5	2.6	2.4	2.4		
n										16	46	135	299	189	122	24		
Dry Balearics																		
Mean									67.0	64.3	64.0	64.3	65.0	65.1	65.4	65.5	64.9	63.3
SD									2.0	2.4	2.8	2.9	2.9	3.0	2.9	2.2	2.9	2.5
n									3	97	232	442	750	712	588	121	33	9
Wet Balearics																		
Mean												68.1	67.7		67.3			
SD												1.7	3.5		0.8			
n												7	12		3			
Chafarinas																		
Mean												66.9	66.5	65.6	65.5			
SD												1.9	1.5	2.2	1.1			
n												7	12	20	4			
N Morocco																		
Mean												66.8	68.5	66.3	65.8	65.2		
SD												1.5	2.0	2.0	1.2	0.6		
n												4	5	9	10	3		
S Morocco																		
Mean																		
SD																		
n																		

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean									2.3	2.1	2.2	1.8	1.6	1.5	1.4	1.7	1.3	1.5
SD									1.0	1.3	0.9	1.1	1.0	0.8	1.2	1.1	0.6	0.6
n									4	5	11	24	61	80	68	7	3	4
Columbrets																		
Mean									0.0	0.7	0.6	0.7	0.5	0.7	0.8	0.8		
SD									0.0	0.8	0.6	0.6	0.6	0.7	0.7	0.7		
n									3	22	51	165	332	215	116	17		
Dry Balearics																		
Mean									2.0	1.3	1.2	1.2	1.3	1.3	1.4	1.3	1.3	1.5
SD									1.0	0.8	0.8	0.7	0.9	0.9	0.9	1.0	1.0	1.0
n									3	99	238	512	819	801	633	169	61	30
Wet Balearics																		
Mean												1.3	1.9		2.0			
SD												0.8	0.7		1.0			
n												7	14		3			
Chafarinas																		
Mean												1.4	1.7	0.6	1.2			
SD												0.5	0.7	0.7	0.8			
n												7	12	21	5			
N Morocco																		
Mean												0.5	2.2	1.1	1.7	1.3		
SD												0.6	0.8	1.0	0.7	0.6		
n												4	6	9	10	3		
S Morocco																		
Mean																		
SD																		
n																		

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean									14.6	14.6	14.2	14.4	13.6	13.8	13.5	14.2	13.4	15.0
SD									1.2	1.5	1.6	1.2	1.2	1.3	1.3	0.5	1.4	1.4
n									4	5	11	24	62	79	69	7	3	4
Columbrets																		
Mean									12.6	11.9	12.3	12.2	11.8	12.1	12.4	12.9		
SD									1.0	1.2	1.2	1.1	1.1	1.1	1.2	1.2		
n									3	22	48	167	355	261	135	24		
Dry Balearics																		
Mean									13.6	12.8	12.7	12.7	12.9	13.1	13.2	13.8	13.8	14.0
SD									0.6	1.2	1.3	1.3	1.4	1.6	1.4	1.5	1.5	1.9
n									3	96	236	499	801	787	624	161	59	30
Wet Balearics																		
Mean												13.5	14.6		14.7			
SD												1.0	1.3		0.8			
n												7	14		3			
Chafarinas																		
Mean												13.7	13.1	13.3	13.5			
SD												1.0	0.6	1.2	1.8			
n												7	12	21	5			
N Morocco																		
Mean												13.2	15.9	14.4	14.1	13.6		
SD												1.1	0.7	1.1	0.9	0.4		
n												4	6	9	10	3		
S Morocco																		
Mean																		
SD																		
n																		

Appendix 1. (Cont.).

Ficedula hypoleuca

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							62.0	62.9	62.2	62.1	61.5	61.5	61.1	60.9	60.5	61.1	60.3	61.7
SD							1.3	1.9	1.5	1.7	1.7	1.6	1.4	1.5	1.6	1.4	0.9	1.9
n							5	22	153	188	218	349	317	321	127	19	4	6
Columbrets																		
Mean									61.9	61.5	61.2	61.0	60.8	60.4	60.4	61.3		
SD									1.7	1.8	1.7	1.8	1.8	1.5	1.5	1.4		
n									13	47	76	119	91	58	57	6		
Dry Balearics																		
Mean							62.2	62.1	62.0	61.2	61.0	60.8	60.6	60.3	60.2	59.6	60.6	60.7
SD							1.3	1.8	1.9	1.8	1.7	1.8	1.7	1.6	1.6	1.5	1.9	1.5
n							11	50	100	471	663	1033	951	688	307	41	38	3
Wet Balearics																		
Mean										62.6	61.5	61.3	61.2					
SD										1.3	1.5	1.5	1.4					
n										14	15	44	20					
Chafarinas																		
Mean											62.2	59.5						
SD											0.3	1.4						
n											3	4						
N Morocco																		
Mean									61.8	59.7	60.2	60.2	61.0	60.2	60.2			
SD									1.5	1.9	1.6	1.4	1.9	1.5	0.3			
n									4	10	15	14	15	26	3			
S Morocco																		
Mean							61.5	61.7	61.3	61.7								
SD							1.6	1.5	1.4	1.5								
n							16	18	40	13								

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							2.4	2.1	2.0	2.0	2.0	2.2	2.0	2.0	2.1	2.5	2.8	2.4
SD							1.1	1.2	1.0	1.2	1.2	1.1	1.1	1.1	1.1	0.9	0.5	1.0
n							5	22	154	190	223	361	355	345	132	19	4	7
Columbrets																		
Mean									0.8	1.0	0.7	0.6	0.5	0.6	1.1			
SD									1.0	0.9	0.9	0.8	0.7	0.6	0.7			
n									12	65	84	151	117	89	51			
Dry Balearics																		
Mean							1.3	1.8	1.7	1.5	1.5	1.5	1.6	1.6	1.7	2.1	1.6	2.6
SD							0.6	1.0	1.2	1.0	1.1	1.0	1.1	1.1	1.1	1.2	1.1	0.7
n							12	51	102	498	744	1203	1072	860	376	56	41	9
Wet Balearics																		
Mean										2.6	1.9	2.3	2.8					
SD										1.3	1.0	1.0	1.0					
n										14	16	45	20					
Chafarinas																		
Mean											1.3	1.5						
SD											0.6	1.3						
n											3	4						
N Morocco																		
Mean									1.2	2.1	1.4	1.7	2.0	2.6	2.6			
SD									1.1	1.4	1.1	1.2	1.2	1.1	1.1			
n									5	17	25	19	16	28	5			
S Morocco																		
Mean							2.3	2.3	2.0	2.5								
SD							1.1	1.1	1.0	1.1								
n							16	18	39	13								

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							12.4	11.8	11.9	11.9	12.1	12.0	11.8	11.9	11.8	12.3	11.3	12.2
SD							0.6	0.9	0.9	1.2	1.1	1.1	1.0	1.0	0.9	0.7	0.5	1.0
n							5	22	152	190	222	355	351	339	131	19	4	6
Columbrets																		
Mean									10.7	10.7	10.7	10.5	10.5	10.5	10.8	11.6		
SD									0.5	1.3	1.2	1.0	1.0	0.9	1.0	1.1		
n									13	75	84	168	118	90	61	5		
Dry Balearics																		
Mean							11.2	11.4	11.3	11.3	11.4	11.5	11.4	11.5	11.5	12.1	11.9	12.0
SD							1.7	1.0	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.3	1.1	0.9
n							12	50	102	478	724	1169	1040	839	366	54	40	9
Wet Balearics																		
Mean										12.9	11.7	11.8	12.9					
SD										1.5	1.5	1.4	1.5					
n										14	16	45	20					
Chafarinas																		
Mean											11.6	11.3						
SD											1.6	0.9						
n											3	4						
N Morocco																		
Mean									12.0	12.4	11.6	12.2	12.7	12.2	12.5			
SD									1.0	1.2	0.9	1.4	1.2	1.4	0.7			
n									5	15	23	19	16	26	5			
S Morocco																		
Mean							12.8	12.5	11.9	12.0								
SD							1.3	0.9	1.1	0.8								
n							16	18	39	13								

Appendix 1. (Cont.).

Lanius senator

Third primary

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							72.9	75.7	75.5	72.6	73.7	73.2	73.5	73.2	72.6	74.4	74.5	
SD							2.3	3.6	3.3	2.9	3.3	2.4	2.1	2.5	2.5	1.8	2.1	
n							12	13	3	16	20	26	55	37	22	6	7	
Columbrets																		
Mean							72.2	75.5	74.8	73.0	73.2	72.9	72.9	72.9	72.3	73.3		
SD							2.3	2.8	3.4	2.4	2.6	3.0	2.8	2.1	1.8	1.6		
n							23	15	23	101	142	100	66	71	47	7		
Dry Balearics																		
Mean				77.2	76.0	76.0	74.2	75.1	74.6	73.9	72.9	72.9	72.8	72.2	72.4	72.6	73.3	
SD				0.3	1.9	2.2	3.1	2.9	3.0	2.8	2.8	2.7	2.6	2.8	2.6	2.6	4.6	
n				3	12	20	68	81	65	172	189	212	179	148	99	24	3	
Wet Balearics																		
Mean										77.0		76.0			75.3			
SD										1.9		1.7			1.5			
n										4		3			3			
Chafarinas																		
Mean														70.8	74.7			
SD														1.5	1.5			
n														8	3			
N Morocco																		
Mean										71.5	73.0							
SD										1.3	3.3							
n										3	3							
S Morocco																		
Mean							71.5	71.6		72.3	71.4	72.3						
SD							1.8	1.2		2.5	2.3	2.0						
n							10	9		7	9	16						

Fat score

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							1.5	2.1	2.5	1.5	1.7	1.7	1.4	1.2	1.7	1.0	2.0	
SD							0.9	1.0	1.9	1.0	1.5	1.0	1.0	1.1	1.2	0.6	0.9	
n							14	14	4	16	21	26	58	42	23	6	6	
Columbrets																		
Mean								1.3	1.5	0.8	0.8	0.8	0.9	1.0	0.9	0.4		
SD								1.1	0.9	0.7	0.7	0.8	0.8	0.8	0.6	0.5		
n								7	27	115	201	116	67	77	40	7		
Dry Balearics																		
Mean				1.8	1.8	1.9	1.7	1.6	1.6	1.4	1.4	1.4	1.6	1.6	1.4	1.0	1.8	1.3
SD				1.0	0.7	1.2	1.0	1.1	1.0	1.1	0.9	1.0	1.1	1.1	1.0	1.1	0.8	0.6
n				4	12	20	68	85	74	201	214	250	218	163	111	32	6	3
Wet Balearics																		
Mean										1.8		2.0			1.7			
SD										0.8		1.0			1.2			
n										5		3			3			
Chafarinas																		
Mean														0.1	0.0			
SD														0.4	0.0			
n														8	3			
N Morocco																		
Mean										1.7	2.3							
SD										1.2	0.6							
n										3	3							
S Morocco																		
Mean							1.1	1.2		1.0	1.0	1.1						
SD							0.7	0.8		0.0	0.0	0.5						
n							10	9		7	9	16						

Body mass

	March						April						May					
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Catalonia																		
Mean							29.6	34.0	35.5	30.3	30.7	29.8	30.4	30.6	29.6	30.8	33.1	
SD							4.2	4.9	5.9	4.4	4.2	3.3	3.4	3.3	3.5	2.6	3.2	
n							13	14	4	15	20	26	58	41	24	6	7	
Columbrets																		
Mean							26.1	32.2	31.4	30.0	29.2	28.5	30.1	29.2	27.7	29.6		
SD							1.8	4.9	4.8	4.0	3.6	3.2	4.1	2.8	2.4	2.9		
n							23	15	34	119	204	118	66	86	46	7		
Dry Balearics																		
Mean				31.5	34.7	33.6	33.0	33.4	32.4	32.6	30.9	31.5	31.4	30.9	30.4	28.7	33.7	34.6
SD				6.5	2.8	4.3	4.1	4.0	4.3	4.5	4.1	4.4	4.4	3.4	4.2	3.0	4.6	3.9
n				3	11	18	70	84	67	202	208	243	202	161	107	30	7	3
Wet Balearics																		
Mean										35.7		34.8			39.5			
SD										1.4		1.2			4.2			
n										5		3			3			
Chafarinas																		
Mean														27.3	29.4			
SD														2.2	1.3			
n														8	3			
N Morocco																		
Mean										29.7	30.8							
SD										2.1	2.3							
n										3	3							
S Morocco																		
Mean							25.3	26.4		26.3	25.9	26.2						
SD							1.0	1.3		1.5	1.9	1.3						
n							9	9		7	9	16						

Appendix 2. We tested for differences in third primary length, body mass, fat score and physical condition between areas and in relation to timing of passage using interactive ANCOVA models. Each of these four biometric variables was set as the dependent variable, area as a factor and pentad as a covariable. In this appendix, for each given species and variable, the significance (*P*) of the effects of region, pentad and its interaction are shown. Moreover, under the name of each area appear the abbreviations of the other areas with which significant differences were found according to post-hoc tests conducted applying the Bonferroni correction (brackets indicate marginally significant differences [$P < 0.1$] and 'NA' unavailability). The column 'r' indicates the coefficient of the correlation conducted between each variable and pentad in each of the main seven study areas (only significant tests are shown; $P < 0.05$). See the methodological introduction for further details.

	Significance (P) in ANCOVA Model			Catalonia (CA)		Columbrets (CO)	
Species	**Area**	**Pentad**	**Interaction**	**r**		**r**	
Streptopelia turtur							
Third primary length	0.0038	0.0000	0.1660	-0.48	CO		DB.CA
Body mass	0.0031	0.4663	0.1450	-0.14			DB
Fat	0.0003	0.8690	0.5868				DB
Physical condition	0.4924	0.0009	0.1385			0.21	
n					13		315
Merops apiaster							
Third primary length	0.0703	0.0132	0.8682				
Body mass	0.0000	0.7445	0.1153		DB CO		NM DB CA
Fat	0.0533	0.1753	0.5820				
Physical condition	0.0000	0.3203	0.2329		CO		NM DB CA
n					128		21
Upupa epops							
Third primary length	0.3373	0.2296	0.2855				
Body mass	0.0000	0.5750	0.1175	0.23	DB CO		DB WB CA
Fat	0.2035	0.0237	0.9831				
Physical condition	0.0000	0.1535	0.2218	0.32	DB CO		DB WB CA
n					81		56
Riparia riparia							
Third primary length	0.3043	0.8503	0.9612				
Body mass	0.0000	0.0000	0.6628	0.23	DB WB CO		CA
Fat	0.0103	0.0001	0.0031	0.27	DB CO		WB CA
Physical condition	0.0000	0.0000	0.7212	0.32	DB WB CO		(NM) CA
n					522		7
Hirundo rustica							
Third primary length	0.0000	0.0005	0.2102	-0.03	SM (WB)		SM WB
Body mass	0.0000	0.0000	0.0000	0.15	SM NM DB CO	-0.19	SM NM DB WB CA
Fat	0.0000	0.0000	0.0000	0.06	NM DB CO	-0.15	SM NM DB WB CA
Physical condition	0.0000	0.0000	0.0000	0.18	SM NM DB CO	-0.13	SM NM DB WB CA
n					5,570		337
Delichon urbica							
Third primary length	0.0385	0.1395	0.0352				
Body mass	0.0000	0.0036	0.0133	0.19	DB CO		DB WB CA
Fat	0.0001	0.2608	0.0018	0.18	DB CO		DB WB CA
Physical condition	0.0000	0.0130	0.0005	0.27	DB CO		DB WB CA
n					126		42
Anthus trivialis							
Third primary length	0.0001	0.0000	0.0002	-0.48			DB
Body mass	0.0000	0.5195	0.3744		CO (DB)		DB CA
Fat	0.0000	0.0625	0.5846		CO		DB WB CA
Physical condition	0.0000	0.0130	0.7727		DB CO		DB WB CA
n					53		177
Motacilla flava							
Third primary length	0.0071	0.1102	0.2651		(CO)		(CA)
Body mass	0.0000	0.7904	0.3227		DB CO		SM DB WB CA
Fat	0.0000	0.0014	0.3006	-0.17	SM DB CO		DB CA
Physical condition	0.0000	0.1405	0.1843		DB CO		SM NM DB WB CA
n					224		126

Dry Balearics (DB)		Wet Balearics (WB)		Chafarinas (CH)		N Morocco (NM)		S Morocco (SM)	
r		r		r		r		r	
-0.20	CO				NA		NA		NA
	CO				NA		NA		NA
	CO				NA		NA		NA
					NA		NA		NA
	677	12							
			NA		NA				NA
	CO CA		NA		NA	0.73	CO		NA
			NA		NA				NA
	CO		NA		NA	0.90	CO		NA
	486						6		
					NA		NA		NA
	CO CA		CO		NA		NA		NA
-0.10					NA		NA		NA
	CO CA		CO		NA		NA		NA
	364		11						
					NA		NA		NA
	CA		CA		NA		NA		NA
	CA	0.79	DB CO		NA		NA		NA
	CA		CA		NA		NA		NA
	51		14						
-0.07	SM WB		SM NM DB CO (CA)				SM WB		NM DB WB CO CA
0.09	SM NM WB CO CA		SM NM DB CO			0.43	SM DB WB CO CA		NM DB WB CO CA
0.17	SM NM WB CO CA	0.20	NM DB CO			0.34	SM DB WB CO CA		NM CO
0.10	SM NM WB CO CA		SM NM DB CO		SM NM	0.49	SM CH DB WB CO CA	0.15	NM CH DB WB CO CA
	1,558		344		9		108		206
	(WB)	0.36	(DB)		NA		NA		
0.22	WB CO CA		DB CO		NA		NA		
	WB CO CA	-0.36	DB CO		NA		NA		
0.20	WB CO CA	-0.40	SM DB CO		NA		NA		WB
	173		31						14
-0.15	CO	-0.73			NA		NA		
	CO (CA)				NA		NA		
	CO		CO		NA		NA		
	WB CO CA		SM DB CO		NA		NA		WB
	589		8						5
					NA		NA		CA
-0.19	WB CO CA		DB CO		NA		NA		CO
	SM CO CA	-0.93			NA		NA		
	SM WB CO CA		DB		NA		NA	0.28	DB CO
	235		6						61

Appendix 2. (Cont.)

	Significance (P) in ANCOVA Model			Catalonia (CA)		Columbrets (CO)	
Species	Area	Pentad	Interaction	r		r	
Erithacus rubecula							
Third primary length	0.0000	0.0000	0.0597	-0.21	DB	-0.35	DB (WB)
Body mass	0.0000	0.0000	0.0344	-0.12	(NM) DB WB CO	-0.23	NM DB WB CA
Fat	0.0004	0.0000	0.0001	0.15	DB CO	0.10	NM DB WB CA
Physical condition	0.0000	0.0004	0.0044	-0.06	NM DB WB CO	-0.17	NM DB WB CA
n					1,877		638
Luscinia megarhynchos							
Third primary length	0.0016	0.0000	0.0020	-0.28	NM (WB) CO	-0.19	DB WB CA
Body mass	0.0000	0.7691	0.0137		DB WB CO	0.05	NM DB WB CA
Fat	0.0000	0.0076	0.0000	-0.30	NM DB CO		NM DB WB CA
Physical condition	0.0000	0.0000	0.0042	0.09	NM DB WB CO	0.13	NM DB WB CA
n					1,607		1,164
Phoenicurus phoenicurus							
Third primary length	0.0000	0.0000	0.3297	-0.18	DB CO	-0.07	CA
Body mass	0.0008	0.0065	0.0042		SM CO		NM (CH) DB WB CA
Fat	0.0000	0.7353	0.0004	0.06	SM DB CO	-0.10	NM DB WB CA
Physical condition	0.0090	0.0312	0.0210		SM NM CO	0.06	SM NM DB WB CA
n					1,146		1,384
Saxicola rubetra							
Third primary length	0.0000	0.0000	0.3611	-0.29	DB CO		CA
Body mass	0.0000	0.9491	0.8195		SM CH CO		SM (NM) DB CO CA
Fat	0.0000	0.0079	0.4213		SM CH CO		NM DB WB CA
Physical condition	0.0000	0.0000	0.6245		NM DB WB CO		NM DB WB CA
n					341		98
Turdus philomelos							
Third primary length	0.1195	0.0005	0.7099	-0.16		-0.27	
Body mass	0.0049	0.0422	0.0345		DB CO (WB)		CA
Fat	0.0000	0.0011	0.6756	0.16	DB WB CO		DB CA
Physical condition	0.0000	0.2404	0.0716		DB CO		CA
n					245		66
Locustella naevia							
Third primary length	0.0001	0.0058	0.7854	-0.12	DB CO		CA
Body mass	0.0000	0.1563	0.4485	0.13	DB CO		CA
Fat	0.0000	0.2037	0.2053	0.12	DB CO		CA
Physical condition	0.0000	0.0530	0.5372	0.16	DB CO		CA
n					325		70
Acrocephalus schoenobaenus							
Third primary length	0.0000	0.5714	0.1751		NM CO		WB CA
Body mass	0.0000	0.0261	0.3217	0.10	(NM) DB WB CO		WB CA
Fat	0.0000	0.0812	0.2470		NM DB WB CO		WB CA
Physical condition	0.0000	0.0339	0.1714	0.11	DB WB		WB
n					461		40
Acrocephalus scirpaceus							
Third primary length	0.0000	0.0123	0.0043	-0.15	SM NM DB CO		SM NM DB
Body mass	0.0000	0.0000	0.0000	-0.14	SM NM CH DB CO		NM DB WB CA
Fat	0.0000	0.0000	0.0003	-0.09	NM CH DB CO		NM DB WB CA
Physical condition	0.0000	0.0000	0.0000	-0.10	SM NM CH DB CO		NM DB WB CA
n					9,674		244

Dry Balearics (DB)		Wet Balearics (WB)		Chafarinas (CH)		N Morocco (NM)		S Morocco (SM)	
r		r		r		r		r	
-0.21	CO CA		(CO)		NA				NA
-0.11	NM WB CO CA		DB CO CA		NA		DB CO (CA)		NA
0.04	NM CO CA	0.32	CO		NA		DB CO		NA
	NM WB CO CA		DB CO CA		NA		DB CO CA		NA
	6,004		103				8		
-0.32	NM WB CO		NM DB CO (CA)			-0.29	DB WB CA		NA
	NM WB CO CA		NM CH DB CO CA		WB	-0.15	DB WB CO		NA
	NM CO CA	-0.30	(NM) CO				DB (WB) CO CA		NA
0.12	NM WB CO CA		DB CO CA				DB CO CA		NA
	1,921		82		14		243		
-0.15	CA								
0.02	SM WB CO		SM DB CO		SM	-0.39	SM CO		NM CH DB WB CA
	SM CO CA		SM CO			-0.40	SM CO		NM DB WB CA
0.08	SM NM CO		SM CO		SM		SM DB CO CA		NM CH DB WB CO CA
	5,654		16		11		33		21
-0.16	CA								
	SM CH CO		SM CH		NM DB WB CA		SM CH (CO)		NM DB WB CO CA
0.05	SM CH CO		SM CH CO	0.75	NM DB WB CA		SM CH CO		NM DB WB CA
	NM WB CO CA		DB CO CA				DB CO CA		
	1,682		12		9		5		17
					NA		NA		NA
	CA	0.70	(CA)		NA		NA		NA
	CO CA	0.48	CA		NA		NA		NA
	CA	0.68			NA		NA		NA
	370		15						
	CA		NA		NA				NA
	CA		NA		NA				NA
	CA		NA		NA				NA
	CA		NA		NA				NA
	271						13		
			(NM) CO		NA		(WB) CA		
	(NM) WB CA		SM NM DB CO CA		NA		(DB) WB (CA)		WB
	(SM) WB CA		NM DB CO CA		NA	0.28	WB CA		(DB)
	(NM) WB CA		NM DB CO CA		NA		(DB) WB		
	109		18				57		10
-0.08	SM NM CA	-0.35				-0.07	DB CO CA		DB CO CA
	SM NM CH CO CA	-0.44	SM CO		DB CA		SM DB CO CA		NM WB DB CA
	CO CA		CO		CA		CO CA		
	SM CH CO CA	-0.34	SM (NM) CH CO		(NM) DB WB CA		SM (CH) (WB) CO CA		NM DB WB CA
	672		39		19		1,144		85

Appendix 2. (Cont.)

	Significance (P) in ANCOVA Model			Catalonia (CA)		Columbrets (CO)	
Species	**Area**	**Pentad**	**Interaction**	**r**		**r**	
Acrocephalus arundinaceus							
Third primary length	0.0001	0.0000	0.3741	-0.31	NM		
Body mass	0.0000	0.0242	0.0727	-0.06	DB WB CO		NM WB CA
Fat	0.0000	0.2060	0.1316		NM WB		NM WB
Physical condition	0.0000	0.0641	0.2296	0.06	DB WB (CO)		NM WB (CA)
n					1,070		5
Hippolais icterina							
Third primary length	0.0719	0.0042	0.0674		NM		(NM)
Body mass	0.0000	0.0000	0.9083	0.32	NM CO		NM DB CA
Fat	0.0000	0.0004	0.7292		NM CO		NM DB CA
Physical condition	0.0000	0.0001	0.9657	0.36	NM CO		NM DB CA
n					48		27
Hippolais polyglotta							
Third primary length	0.0000	0.0000	0.2835	-0.29	NM CH DB CO	-0.26	NM CH CA
Body mass	0.0000	0.0387	0.0000	-0.18	NM CH DB CO		NM DB CA
Fat	0.0000	0.1150	0.0000	-0.14	NM CH CO		NM CH DB CA
Physical condition	0.0000	0.0554	0.0000		CH DB CO		NM DB CA
n					662		537
Sylvia cantillans & moltonii							
Third primary length	0.0000	0.0363	0.0000	-0.33	NM CO	-0.16	DB WB CA
Body mass	0.0000	0.1095	0.0055	-0.10	NM DB CO		NM DB CA
Fat	0.0007	0.0332	0.0002		NM DB CO	-0.15	NM DB (WB) CA
Physical condition	0.0000	0.0191	0.9085		NM DB CO		NM CH CA
n					651		561
Sylvia communis							
Third primary length	0.0000	0.0000	0.0868	-0.12	NM CH DB CO	-0.06	CH DB CA
Body mass	0.0000	0.0077	0.0000	-0.12	CH DB (WB) CO		NM DB WB CA
Fat	0.0000	0.1766	0.0000		NM CH DB CO	-0.17	NM DB WB CA
Physical condition	0.0000	0.0009	0.0007		CH DB CO	-0.07	NM DB WB CA
n					1,139		1,189
Sylvia borin							
Third primary length	0.0000	0.0000	0.0090	0.11	NM CH DB CO	0.14	NM CH WB CA
Body mass	0.0000	0.0347	0.0000	0.18	NM DB WB CO		(SM) NM DB WB CA
Fat	0.0000	0.0000	0.0000	0.10	NM DB CO	-0.08	SM NM CH DB WB CA
Physical condition	0.0000	0.0000	0.0000	0.16	NM DB CO		NM CH DB WB CA
n					1,493		1,021
Sylvia atricapilla							
Third primary length	0.0460	0.0007	0.0110	-0.10	DB	-0.10	DB
Body mass	0.0003	0.0037	0.0085	-0.14	NM DB WB		NM DB WB
Fat	0.0000	0.0000	0.0000	-0.12	NM (WB)	-0.08	NM DB
Physical condition	0.0000	0.0000	0.5479	-0.12	NM DB WB		NM DB WB
n					4,154		537
Phylloscopus bonelli							
Third primary length	0.0000	0.0000	0.7678	-0.28	NM CH DB		CH
Body mass	0.0000	0.0042	0.0639		CO	-0.23	DB CA
Fat	0.0000	0.2913	0.0407		CO	-0.16	NM DB CA
Physical condition	0.0000	0.0000	0.0305		CO	-0.16	NM (CH) DB CA
n					139		214

Dry Balearics (DB)		Wet Balearics (WB)		Chafarinas (CH)		N Morocco (NM)		S Morocco (SM)	
r		r		r		r		r	
-0.36	(WB)	-0.42	NM		NA	-0.32	CA WB		NA
	NM WB CA		NM DB CA CO		NA		DB WB CO		NA
	NM WB		DB CO CA		NA		DB CO CA		NA
	NM WB CA		DB CO CA		NA		DB CO		NA
	59		60				83		
	NM (CO)		NA		NA	-0.65	DB CA		NA
0.18	NM CO		NA		NA		DB CO CA		NA
0.12	NM CO		NA		NA		DB CO CA		NA
0.15	NM CO		NA		NA		DB CO CA		NA
	389						10		
-0.13	NM CH CA		NA	-0.15	DB CO CA		DB CO CA		
0.15	CH CO CA		NA	-0.14	NM DB CA		CH CO CA		
0.14	NM CH CO		NA		NM DB CO CA		CH DB CO CA		
0.20	NM CH CO CA		NA		NM DB CA		CH DB CO		
	744				388		180		6
0.05	NM CO		NM CO				DB WB CA		NA
0.07	NM CO CA						DB CO CA		NA
	NM CO CA		(CO)		NM		CH DB CO CA		NA
0.05	NM CH CA		NM		(NM) DB CO		(CH) DB WB CO CA		NA
	1,955		10		22		60		
-0.03	CH CO CA		CH		DB WB CO CA		CA		NA
0.06	NM CH WB CO CA		CH DB CO (CA)		NM DB WB CA		CH DB CO		NA
0.05	NM CH WB CO CA		CH DB CO		NM DB WB CA	0.30	CH DB CO CA		NA
0.06	NM CH CO CA		CH CO		NM DB WB CA		CH DB CO		NA
	5,293		26		41		52		
0.06	NM CH WB CA		NM CH DB CO		DB WB CO CA		DB WB CO CA		
0.22	NM WB CO CA	0.33	CH DB CO CA		NM WB		CH DB CO CA		(CO)
0.11	SM NM CH WB CO CA		NM DB CO		NM DB CO		CH DB WB CO CA		DB
0.19	NM WB CO CA	0.32	DB		NM CO		CH DB CO CA		
	4,978		54		46		484		9
-0.15	(WB) CO CA	-0.32	(DB)		NA	-0.13			
-0.17	NM (WB) CO CA	-0.24	NM (DB) CO CA		NA	-0.13	SM DB WB CO CA		NM
-0.16	CO CA		(CA)		NA		CO CA		
-0.12	NM CO CA	-0.17	NM CO CA		NA		SM DB WB CO CA		NM
	4,340		151				283		31
-0.21	CH CA		NA		DB CO CA		CA		NA
	CO		NA						NA
0.09	CO		NA				CO		NA
0.09	CO		NA		(CO)		CO		NA
	694				10		11		

Appendix 2. (Cont.)

	Significance (P) in ANCOVA Model			Catalonia (CA)		Columbrets (CO)	
Species	Area	Pentad	Interaction	r		r	
Phylloscopus sibilatrix							
Third primary length	0.0002	0.0000	0.8361	-0.40	DB	-0.21	
Body mass	0.0000	0.0016	0.0844	0.19	(NM) DB CO		NM CH DB WB CA
Fat	0.0000	0.0000	0.8714	0.15	NM DB CO		NM DB WB CA
Physical condition	0.0000	0.0000	0.0564	0.35	CO	0.22	NM (CH) DB WB CA
n					195		150
Phylloscopus collybita							
Third primary length	0.0000	0.0000	0.0000	-0.38	DB	-0.33	DB WB
Body mass	0.0000	0.0000	0.0000	-0.20	NM DB CO	-0.20	SM NM (DB) WB CA
Fat	0.0000	0.0002	0.0000		(DB) CO		NM DB WB CA
Physical condition	0.0000	0.0270	0.0004		SM NM DB CO		SM NM DB WB CA
n					2,154		856
Phylloscopus trochilus							
Third primary length	0.0000	0.0000	0.0000	-0.41	NM CH DB WB CO	-0.31	NM CH DB WB CA
Body mass	0.0000	0.0000	0.0000	-0.17	SM CH WB CO	-0.31	SM NM CH DB WB CA
Fat	0.0000	0.0000	0.0000	0.17	NM CH DB CO	-0.18	SM NM DB WB CA
Physical condition	0.0000	0.0000	0.0000	0.02	SM NM CH DB CO	-0.23	SM NM CH DB WB CA
n					8,775		6,624
Muscicapa striata							
Third primary length	0.0000	0.0000	0.0027		(CH) DB CO	0.07	NM CH (DB) WB CA
Body mass	0.0000	0.0000	0.0000	-0.12	NM DB CO	0.10	NM CH DB WB CA
Fat	0.0000	0.0006	0.0000	-0.18	CH DB CO		NM DB WB CA
Physical condition	0.0000	0.0000	0.0014		NM DB CO	0.07	NM CH DB WB CA
n					256		798
Ficedula hypoleuca							
Third primary length	0.0000	0.0000	0.1039	-0.29	SM NM DB CO	-0.19	NM CA
Body mass	0.0000	0.0059	0.0004		DB WB CO		NM DB WB CA
Fat	0.0288	0.0002	0.0158		DB WB CO	-0.12	(SM) NM DB WB CA
Physical condition	0.0000	0.0000	0.0009	0.06	NM DB CO		SM NM DB WB CA
n					1,716		466
Lanius senator							
Third primary length	0.0000	0.0000	0.0001		WB		WB
Body mass	0.0000	0.0000	0.0506		SM DB WB CO	-0.09	SM DB WB CA
Fat	0.0000	0.0302	0.7642		SM NM CO		NM DB CA
Physical condition	0.0000	0.0000	0.1664		SM DB WB CO		SM DB WB CA
n					213		529

Dry Balearics (DB)		Wet Balearics (WB)		Chafarinas (CH)		N Morocco (NM)		S Morocco (SM)	
r		r		r		r		r	
-0.37	CA					-0.30			NA
0.09	NM WB CO CA		DB	-0.78	CO		DB CO (CA)		NA
0.14	NM WB CO CA		DB				DB CO CA		NA
0.19	NM CO		CO	-0.68	(CO)		DB CO		NA
	800		48		9		50		
-0.10	CO CA	-0.19	CO					0.29	
	SM NM WB (CO) CA	0.23	DB CO				DB CO CA		DB CO
-0.10	CO (CA)	0.31	CO				CO		
0.05	SM NM WB CO CA	0.33	DB CO				DB CO CA		DB CO CA
	3,296		138		6		82		43
-0.41	NM CH WB CO CA	-0.33	SM NM CH DB CO CA	-0.29	DB WB CO CA	-0.20	DB WB CO CA		WB
-0.30	SM CH WB CO		SM CH DB CO CA	-0.31	SM NM DB WB CO CA	-0.12	SM CH CO		NM CH DB WB CO CA
	NM CH CO CA	0.26	CH CO	-0.15	SM NM DB WB CA	0.10	CH DB CO CA		CH CO
-0.15	SM NM CH CO CA		SM CH CO	-0.24	SM NM DB WB CO CA		SM CH DB CO CA	0.25	NM CH DB WB CO CA
	26,550		356		263		513		92
0.13	NM WB (CO) CA		DB CO		(CO) CA		DB CO		NA
0.17	NM WB CO CA		CH DB CO		NM WB CO	-0.45	CH DB CO CA		NA
0.08	WB CO CA	0.42	CH DB CO		WB CA	-0.35	CO		NA
0.10	NM WB CO CA	0.48	DB CO		NM CO		CH DB CO CA		NA
	2,916		25		43		35		
-0.22	(NM) WB CA		NM DB				(DB) WB CO CA		CA
0.06	NM WB CO CA		CH DB CO CA		(NM) WB		(CH) DB	-0.23	
0.06	NM WB CO CA	0.20	CH DB CO CA		WB	0.18	DB CO		(CO)
0.11	SM NM WB CO CA	0.25	DB CO				DB CO CA	-0.23	DB CO
	4,277		101		9		90		88
-0.27	WB		SM NM (CH) DB CO CA		(WB)		WB		WB
-0.21	SM WB CO (CA)		SM NM CH DB CO CA		(SM) WB		SM WB		NM (CH) DB WB CO CA
	SM NM CO			-0.67	NM		SM CH DB CO CA		NM DB CA
-0.13	SM CH WB CO CA		SM NM CH DB CO CA		DB WB		SM WB		NM DB WB CO CA
	1,195		13		13		10		49

Resum

Cada primavera les aus migratòries de llarga distància tornen a Europa des de les seves àrees d'hivernada del sud del Sàhara després d'haver creuat dos grans barreres geogràfiques en ràpida successió, el desert del Sàhara i el mar Mediterrani. Es tracta d'un viatge molt exigent, sobretot en aquesta època de l'any en què les aus necessiten arribar a les seves àrees de cria tan aviat com sigui possible per establir els seus territoris i trobar parella.

Spring migration in the western Mediterranean and NW Africa: results from 16 years of the Piccole Isole *project* presenta les principals conclusions obtingudes per una xarxa d'estacions d'anellament que ha estat en funcionament entre 1992 i 2007 a Espanya i el Marroc. Aquesta xarxa ha proporcionat, per primera vegada, l'oportunitat d'estudiar al mateix temps la migració primaveral d'aus en tota la conca mediterrània: tant a les zones des d'on procedeixen els migrants (nord-oest d'Àfrica), com en les àrees on les aus paren mentre realitzen la travessia pel mar (illes de la Mediterrània) o quan segueixen rutes continentals menys exigents energèticament (costa d'Espanya).

El treball es basa fonamentalment en els resultats obtinguts per a un conjunt de 30 espècies, totes elles tractades àmpliament en els capítols específics que formen el gruix d'aquesta monografia. Aquestes espècies inclouen 26 migradors transsaharians (tots excepte tres passeriformes), dues espècies que hivernen al nord del Sàhara (Tord comú i Pit-roig) i dos amb patrons migratoris mixtos (Tallarol de casquet i Mosquiter comú).

Els resultats presentats en aquesta monografia emfatitzen que cal tenir en compte les característiques geogràfiques i d'hàbitat específiques de cada lloc a l'hora d'estudiar la condició física d'arribada i el comportament d'aturada i alimentació (stopover) dels ocells migradors. No obstant això, s'han observat alguns patrons generals molt evidents. El temps d'estada i el guany de pes són generalment més alts al nord-oest d'Àfrica, on els ocells poden recuperar una part significativa de les reserves energètiques perdudes al creuar el Sàhara. Un cop a Europa, els ocells que migren a través del continent, en general, es mouen mitjançant una combinació de vols curts i escales breus que els permeten mantenir en equilibri les seves reserves energètiques. En canvi, els que migren per les illes de l'oest de la Mediterrània estan exposats a vols sense escales molt més exigents energèticament i, excepte quan fan ús de les poques zones humides disponibles, tenen menys oportunitats per reposar energies. Malgrat aquests problemes, entre els migradors de llarga distància que passen per l'oest de la Mediterrània, una major proporció ho fa directament a través del mar a la primavera que a la tardor; d'aquesta manera seleccionen la ruta més curta, directa i ràpida.

Resumen

Cada primavera las aves migratorias de larga distancia regresan a Europa desde sus áreas de invernada al sur del Sahara después de haber cruzado dos grandes barreras geográficas en rápida sucesión, el desierto del Sahara y el mar Mediterráneo. Se trata de un viaje muy exigente, sobre todo en esta época del año en que las aves necesitan llegar a sus áreas de cría tan pronto como sea posible a fin de establecer sus territorios y encontrar pareja.

Spring migration in the western Mediterranean and NW Africa: results from 16 years of the Piccole Isole *project* presenta las principales conclusiones obtenidas por una red de estaciones de anillamiento que ha operado entre 1992 y 2007 en España y Marruecos. Esta red ha proporcionado, por primera vez la oportunidad de estudiar al mismo tiempo la migración primaveral de aves en toda la cuenca mediterránea: tanto en las zonas desde donde proceden los migrantes (noroeste de África), como en las áreas donde las aves paran mientras realizan la travesía por el mar (islas del Mediterráneo) o cuando siguen rutas continentales menos exigentes energéticamente (costa de España).

El trabajo se basa fundamentalmente en los resultados obtenidos para un conjunto de 30 especies, todas ellas tratadas ampliamente en los capítulos específicos que forman el grueso de esta monografía. Estas especies incluyen 26 migrantes transaharianos (todos excepto tres paseriformes), dos especies que invernan al norte del Sahara (Zorzal y Petirrojo) y dos con patrones migratorios mixtos (Curruca capirotada y Mosquitero común).

Los resultados expuestos en esta monografía enfatizan que hay que tener en cuenta las características geográficas y de hábitat específicas de cada lugar cuando se estudia la condición física de llegada y el comportamiento de parada y alimentación (stopover) de las aves migratorias. Sin embargo, se han observado algunos patrones generales muy evidentes. El tiempo de estancia y la ganancia de peso son generalmente más altos en el noroeste de África, donde las aves pueden recuperar una parte significativa de las reservas energéticas perdidas al cruzar el Sahara. Una vez ya en Europa, las aves que migran a través del continente, en general, se mueven mediante una combinación de vuelos cortos y escalas breves que les permiten mantener en equilibrio sus reservas energéticas. En cambio, las que migran por las islas del oeste del Mediterráneo están expuestas a vuelos sin escalas mucho más exigente energéticamente y, excepto cuando hacen uso de las pocas zonas húmedas disponibles, tienen menos oportunidades de reponer energías. A pesar de estos problemas, entre los migrantes de larga distancia que pasan por el oeste del Mediterráneo, una mayor proporción lo hace directamente a través del mar en primavera que en otoño; de este modo seleccionan la ruta más corta, directa y rápida.

Abstract

Every spring, long-distance Palaearctic migrants return to Europe from their sub-Saharan wintering grounds after having crossed two large geographical barriers in near succession, the Sahara desert and the Mediterranean Sea. This journey is particularly demanding at this time of year because birds need to reach their breeding grounds as soon as possible to establish territories and find mates.

Spring migration in the western Mediterranean and NW Africa: results from 16 years of the Piccole Isole *project* presents the main findings from a network of ringing stations that were in operation between 1992 and 2007 in Spain and Morocco. This network provided the first opportunity to simultaneously study spring bird migration right across the Mediterranean basin. Migrating birds were studied both in their areas of origin (NW Africa) and also in the areas where they stopped either during the sea crossing (Mediterranean islands) or while following less energetically demanding continental routes (coastal Spain).

The work is essentially based on the results obtained for 30 species, all of which are dealt with extensively in the species accounts that make up the bulk of this monograph. These species include 26 trans-Saharan migrants (all bar three passerines), two species that winter north of the Sahara (Song Thrush and Robin) and two with mixed migratory patterns (Blackcap and Chiffchaff).

The findings show that site-specific habitat and geographic characteristics should be taken into account when studying stopover behaviour and body condition of migrants on arrival. However, some common patterns are evident. Refuelling rates and stopover duration are usually highest in NW Africa, where birds regain a significant portion of the energy reserves lost while crossing the Sahara. Once in Europe, birds migrating through continental areas usually move by means of short flights and brief stopovers during which they optimise fuel loads. However, birds passing through the islands of the W Mediterranean are exposed to much more energetically demanding non-stop flights and, except when taking advantage of the few available wetlands, have fewer opportunities to refuel successfully. Despite these difficulties, a greater proportion of long-distance migrants passing through the W Mediterranean move directly across the sea in spring than in autumn; thereby choosing the shorter, more direct and faster route.

museu de ciències naturals de Barcelona

Every spring long-distance Palaearctic migrants return to Europe from their sub-Saharan wintering grounds after having crossed two large geographical barriers in near succession, the Sahara desert and the Mediterranean sea. This journey is particularly demanding at this time of year because birds need to reach their breeding grounds as soon as possible to establish territories and find mates..

Spring migration in the western Mediterranean and NW Africa: the results of 16 years of the Piccole Isole *project* presents the main findings of a network of ringing stations that were in operation between 1992 and 2007 in Spain and Morocco. This network provided the first opportunity to simultaneously study spring bird migration right across the Mediterranean basin. Migrating birds were studied both in their areas of origin (NW Africa) and also in the areas where they stopped either during the sea crossing (Mediterranean islands) or while following less energetically demanding continental routes (coastal Spain).

The work is essentially based on the results obtained for 30 species, all of which are dealt with extensively in the species accounts that make up the bulk of this monograph. These species include 26 trans-Saharan migrants (all bar three passerines), two species that winter north of the Sahara (Song Thrush and Robin) and two with mixed migratory patterns (Blackcap and Chiffchaff).

GOB Grup Balear d'Ornitologia i Defensa de la Naturalesa
GRUP AU D'ORNITOLOGIA
ICO Institut Català d'Ornitologia
SOM Societat Ornitològica de Menorca
جامعة شعيب الدكالي Université Chouaïb Doukkali
Ajuntament de Barcelona Institut de Cultura
GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN
CSIC