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.

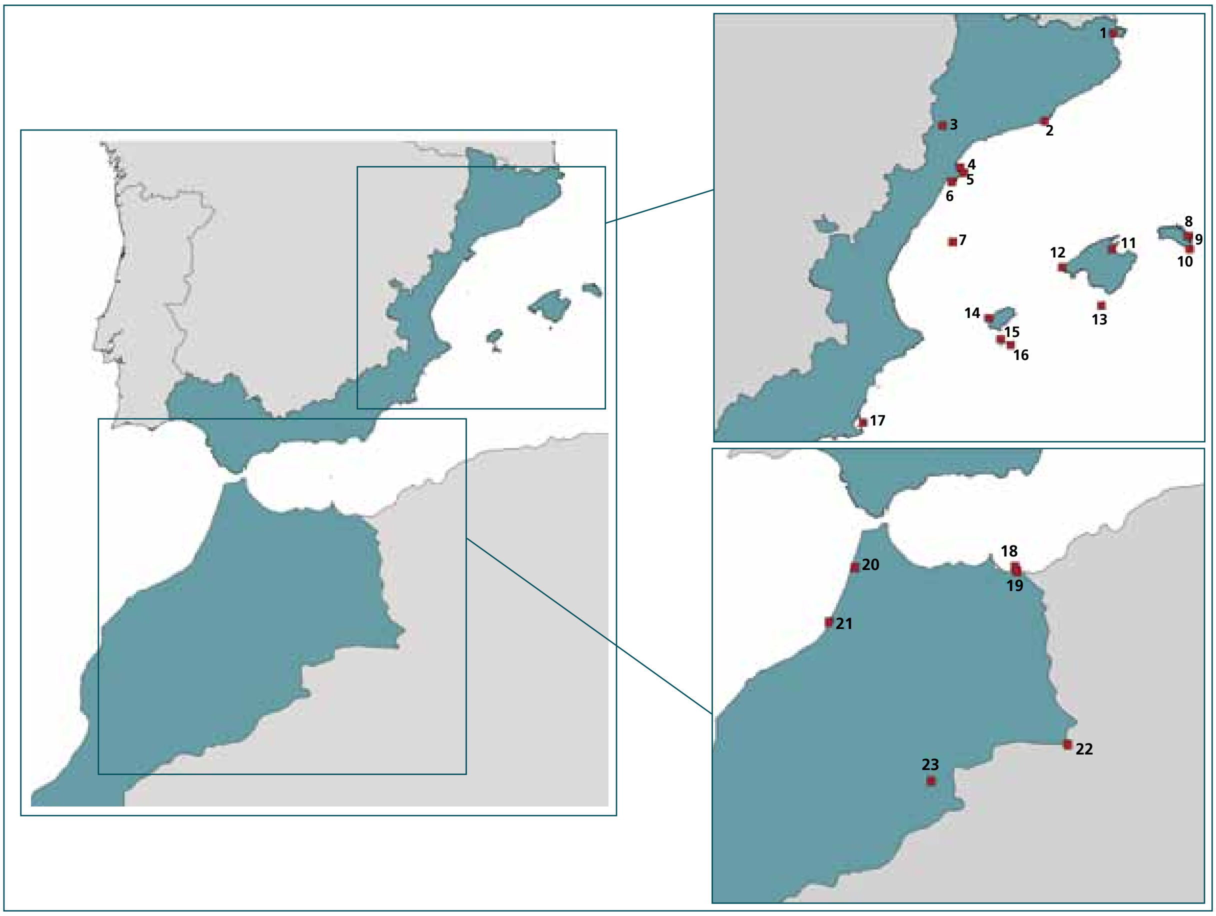

Figure 1. Location of the study sites (red squares). (For abbreviations of location numbers see table 1).

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)