

Application of a roding survey method to the sedentary Eurasian Woodcock *Scolopax rusticola* population in Pico Island, Azores

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Abstract The Eurasian Woodcock *Scolopax rusticola* is a resident species in Azores, Madeira and Canaries (Macaronesian archipelagos) in contrast to its mainly migrant continental populations. The biology and ecology of these insular populations are still poorly known; however, woodcocks are hunted in Azores and Madeira. This work aims to continuing bridging the gap between scientific knowledge and game management of woodcocks in Azores. Working at Pico Island, the main objectives were: (a) to characterize the roding activity of these insular populations, (b) to select the best period of the breeding

season to perform a roding survey and (c) to evaluate how sensitive is this method to variations in abundance because of hunting. From January to July 2002, the number of contacts with roding birds (males) was recorded, at dusk, at three observation points. Roding started in the beginning of February and lasted until late June/early July. The weekly variation in the number of contacts was similar in all points, strongly suggesting that the roding survey should be performed between the beginning of March and middle April. Two of the three observation points, located in an area where woodcock hunting is allowed in alternate years, were surveyed between March 1 and April 15, 2001–2005. The two points presented a similar annual variation pattern in the number of contacts, also suggesting stability in abundance. Sex ratio among birds bagged during three consecutive hunting seasons (October–November, 2002–2004) or among birds collected periodically during two winters (2000–2002) was equal to one, suggesting that annual fluctuations by the roding survey can be extended to the female fraction.

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Introduction

The Eurasian Woodcock *Scolopax rusticola* has a wide-spread Palearctic distribution (Del Hoyo et al. 1996; Ferrand and Gossmann 2001). Despite being a migratory species in most of its distribution area, the Eurasian Woodcock is considered to be a resident breeding species in the majority of the Macaronesian archipelagos, namely in Azores, Madeira and Canaries, Cape Vert being an exception (Godman 1870; Hartert and Ogilvie-Grant 1905; Chavigny and Mayaud 1932; Bannerman and

Bannerman 1966). The Eurasian Woodcock is legally hunted in several islands of Azores, including Pico Island, but the biology and ecology of these insular populations are still poorly known. This situation justifies the urgency in collecting basic data on several aspects, including the analysis of hunting results, to provide a scientific basis for the management and conservation of the species in the archipelago. Among the most urgent tasks to perform is the realistic estimation of abundance and its annual variation.

An annual survey of the breeding population is advised for a proper monitoring of this species (Ferrand 1993). The specific behaviour of the Eurasian Woodcock (Hirons 1980; Ferrand 1989, 1993) hampers the use of classic census methods (Ferrand 1993). An alternative method, based on the registration of contacts with roding birds at fixed observation points, was developed by Ferrand (1989, 1993) and became the main tool to evaluate trends in European populations of this species (Marcström 1988, 1994; Fokin and Blokhin 2000; Estoppey 2001a, b; Mulhauser 2001, 2002; Saari 2002; Fokin et al. 2004; Sandakov 2004; Gossmann et al. 2005).

Roding is a display or advertisement flight in which the male woodcock, at twilight, travels above the woodland canopy calling repeatedly, and its purpose is to find and attract females to mate, not to mark territories (Hirons 1980). This activity normally takes place between February and August (depending of the latitude and altitude), in an area of about 60–100 ha every morning and evening (Ferrand 1979; Hirons 1980, 1983). Most birds display for about twice as long in the evening than in the morning (Hirons 1983; Ferrand 1993). The annual roding area for a single bird can reach 300 ha (Ferrand 1979). Because a bird can display several times over the same area during the same evening roding period, the survey method consists in the registration of the number of contacts (woodcocks seen and/or heard) rather than the absolute number of woodcocks. Nevertheless, Ferrand (1993) points out that a positive and significant correlation was found between the number of contacts and the number of individual birds (estimated by sonographic analysis) in a given area. Therefore, although this technique does not give a precise estimate of the population size, it allows the detection of strong numeric variations in the population of breeding woodcocks, suggesting that it can be safely used as an index of relative abundance (Ferrand 1993). The fraction of the population accessed by this survey method is the male fraction, and it will be important to have data on the population sex ratio, to evaluate if survey results can be extended to the female fraction.

The variation in roding intensity (number of contacts with roding birds per evening roding period) during the breeding season has been studied in migratory or partially migratory European populations (Hirons 1980, 1983; Ferrand 1989, 1993; Fokin and Blokhin 2000) but still not in resident ones like the Azorean populations. The results of a preliminary

study performed in 2001 (Machado et al. 2002), on the woodcock breeding distribution and abundance in Pico Island, showed that local roding activity could present some differences to what was known from other breeding populations: Roding intensity at the beginning of field work (12 February) was already high, suggesting an onset of this activity between the end of January and the beginning of February; there were already signs of a local pattern in the roding intensity during the breeding season, but this could not be confirmed with the sampling periodicity then adopted.

In Pico Island, woodcocks were traditionally hunted when roding, from the end of January until the middle of March. A recent study on the adequacy of the hunting season with respect to the reproductive cycle of the species, which included the analysis of the sexual development of hunted birds, showed that the hunting method used was very selective: The majority of the birds shot were adult males, which presented a sexual development (testicular index, according to Stronach 1983) significantly higher than young males in February (Machado et al. 2006). Being alerted to these results, the regional hunting administration has shifted the hunting season, in 2002, to October and November, where it has remained until the present.

Since 2001, two major areas are considered in Pico Island for woodcock hunting, each corresponding almost to half of the island surface (see Machado et al. 2006 for details); every year, one of them is closed to hunting, and they changed in an annual basis. As the species is resident, this changing provides a good opportunity to evaluate the sensitivity of the roding survey method to population changes because of hunting pressure.

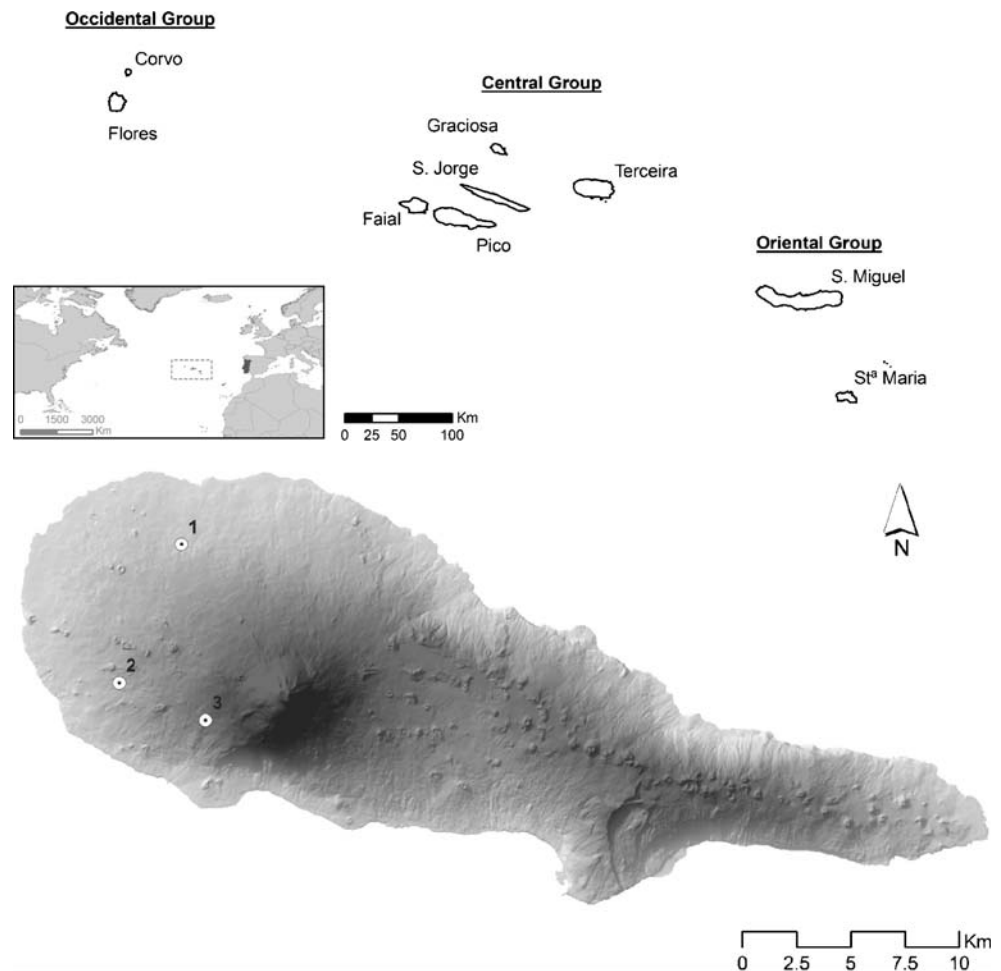
Therefore, the main objectives of the present work were: (1) to characterize the Eurasian Woodcock roding activity in Pico island, Azores archipelago, (2) to select the best period of the breeding season to perform the monitoring of the breeding population using the roding survey method and (3) to evaluate the reliability of the survey method for this resident population namely, its sensitivity to the variation in bird abundances because of the hunting activity, including information about population sex ratio.

Materials and methods

Study area

The study was performed in Pico Island, in the Azores archipelago. This archipelago, located in the North Atlantic Ocean (36–39°N, 25–31°W; Fig. 1), comprises nine main islands of volcanic origin, roughly divided into three distinct groups, with a temperate oceanic climate (Dias 1994; Silva and Smith 2004). The mean annual temperature is 17°C at sea level, and relative humidity near the coast is

Fig. 1 Location of the archipelago of Azores, of Pico Island and the three observation points: 1 Bandeiras (190 m), 2 Candelária (370 m) and 3 Ribeira das Calhetas (850 m)



75–80%, many times reaching saturation values at high places, while rainfall ranges from 1,500 to 3,500 mm, depending on the altitude (Dias 1994; Silva and Smith 2004). Like those of the Madeira and Canaries islands, the Azorean native cloud forest is considered a remnant of the old Tertiary forests that once covered Southern Europe (Sjögren 2000). Pico Island is located in the Central Group (see Fig. 1) and is the second largest island of the archipelago (433 km²). Its landscape is dominated by the Pico Mountain (2,351 m), a volcanic peak. Since the beginning of human settlement (fifteenth century), the natural landscape suffered the impact of several activities, including clearing of the native vegetation for cereal crops and pasture and the introduction of exotic plants like *Pittosporum undulatum* and *Hedychium gardnerianum* (Tutin 1964; Furtado 1984; Sjögren 2000; Silva and Smith 2004). Nevertheless, in this island, it is still possible to find some of the most important areas of natural vegetation of the archipelago (Dias 1994).

Roding activity during the breeding season

Field work was carried out from January to July 2002. Using information from a previous work (Machado et al.

2002), three fixed observation points were selected for observing roding birds at dusk (Fig. 1): Bandeiras, Candelária and Ribeira das Calhetas. Observations were performed at least once a week at each point, or twice a week, if weather conditions allowed.

We followed the survey protocol described by Ferrand (1989, 1993). Observations took place at dusk, in the evening exhibition (roding) period.

For each roding period, the following variables were recorded:

- (1) Total number of contacts with roding birds (seen and/or heard); if several birds flew together, each of them was considered a separate contact
- (2) Number of simultaneous contacts (number of registrations corresponding to two or more birds observed simultaneously)
- (3) Time of contact (universal time; accuracy to the minute)
- (4) Time elapsed between the first and the last contact (duration of the evening roding period)

Observations always began, at least, 1 h before sunset and stopped half an hour after the last contact was registered. Previous work (Machado et al. 2002) suggested

that roding activity could take place as early as January. Therefore, survey began on January 12 (week 3).

Annual variation in roding intensity

The roding survey protocol described before was applied annually in two of the three selected points (Candelária and Ribeira das Calhetas) between March 1 and April 15, from 2001 to 2005. This two observation points were located in the same area concerning woodcock hunting annual permission.

Sex and age ratio among collected birds

During 3 consecutive years, we analysed a sample of birds bagged during the hunting season (October to November): 57 birds in 2002, 88 in 2003 and 44 in 2004. The hunting method was hunting with pointing dogs. Additionally, we used data from some birds that were shot periodically during the winter, for the study on the adequacy of the hunting season relatively to the breeding cycle of the species (Machado et al. 2006); these birds were collected with the cooperation of some local hunters, also using pointing dogs: 25 birds collected from December 2000 till early March 2001 and 17 birds collected from January till early March 2002. Birds were aged (adult or yearling) using wing feather details and moult status (Clausager 1973; Fadat 1995) and sexed after dissection and observation of the gonads. For the 2002 hunting season and the winter samples, the approximate altitude of the kill sites was also recorded for the majority of the cases.

Statistical analysis

A two-way analysis of variance (ANOVA) was used to test for differences (1) in the mean number of contacts (values squared root) with roding birds and (2) in the mean duration of the evening roding period, between observation points (POINT) and months (MONTH) during 2002. Similarly, a two-way ANOVA was used to test for differences in the number of contacts between POINT and years (YEAR), for the annual variation in roding intensity. In all cases, Cochran's *C* test was used to test for homogeneity of variances, and multiple comparisons were performed using the Student–Newman–Keuls test (Underwood 1997).

The weekly coefficient of variation (CV) in the number of contacts with roding birds was calculated and the non-parametric Kruskal–Wallis ANOVA by Ranks Test (*H*) was used to test for differences in CV among months.

The Pearson correlation coefficient was used to assess possible correlations between some variables. A chi-square test (Fowler and Cohen 1986) was used to analyse differences in sex and age frequencies among collected birds, with Yates' correction for continuity whenever appropriate.

The Mann–Whitney *U* test was used to compare the altitude values at which the birds were collected during the 2002 hunting season and during the winter.

The tests were performed using the software package Statistica (StatSoft 2005).

Results

Roding activity during the breeding season

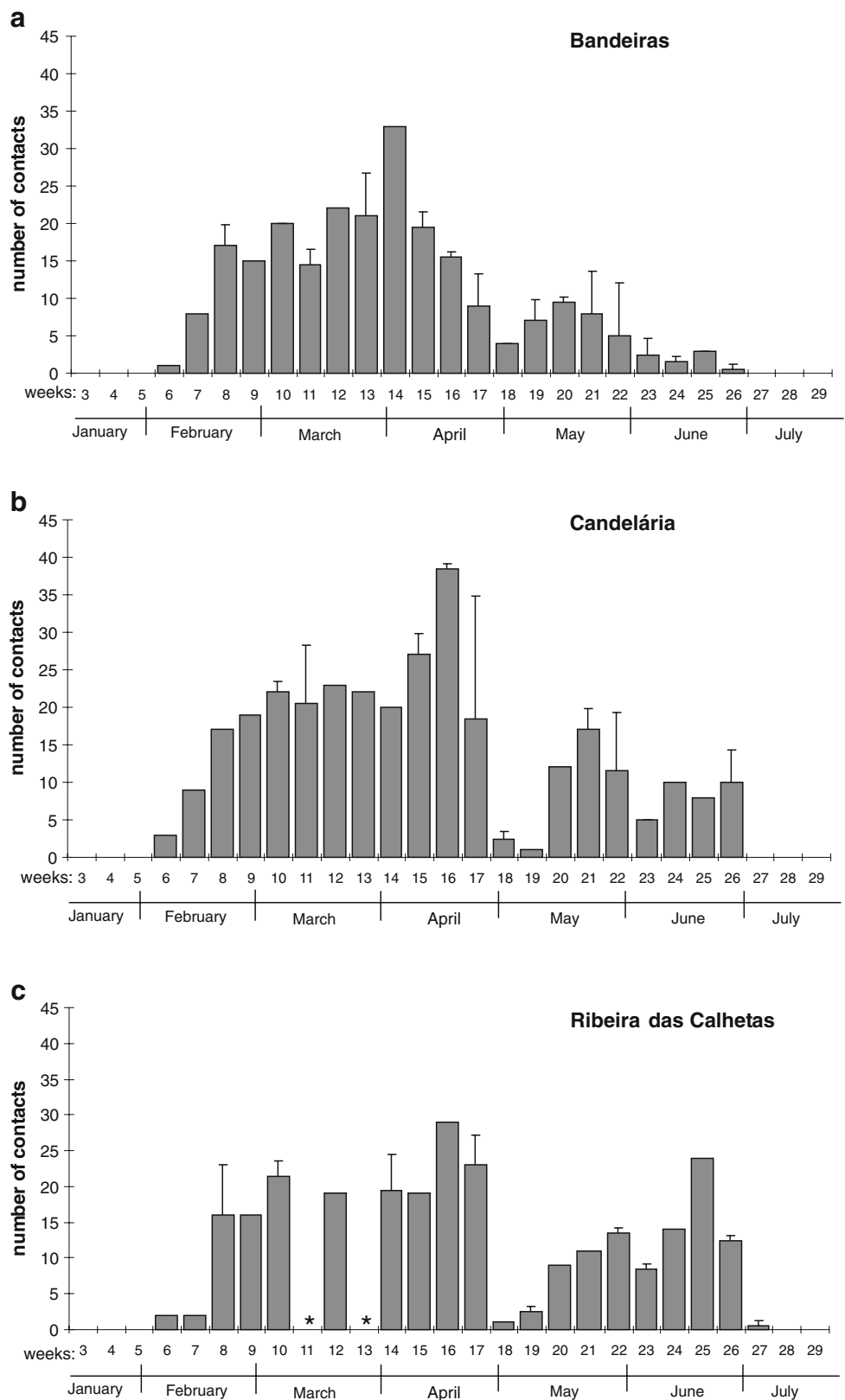
The first roding birds were seen only in February, in all three observation points (Fig. 2). The last roding birds were observed at the end of June (Bandeiras and Candelária) or beginning of July (Ribeira das Calhetas), after a more gradual (Bandeiras) or steeper (Candelária) decrease.

The monthly variation pattern in the number of contacts (Fig. 2) was similar between the three observation points because POINT×MONTH interaction was not significant ($F_{8, 83}=1.23$, $p=0.293$). The number of contacts increased until early March, followed by a period of a relative stability in its values. After mid-April, the values decreased rapidly until the beginning of May and increased again afterward. There were significant differences in the mean value of contacts between points ($F_{2, 83}=3.37$, $p=0.039$). Candelária (mean=14.51, SE=1.23, $n=33$) presented a value similar to Ribeira das Calhetas (mean=13.93, SE=1.37, $n=27$), both higher than Bandeiras (mean=10.59, SE=1.16, $n=38$). Differences in the number of contacts between months were also significant ($F_{4, 83}=13.57$, $p<0.001$), with more contacts in March (mean=19.89, SE=1.71, $n=18$) and April (mean=20.10, SE=1.49, $n=22$) than in the other months (February—mean=9.07, SE=1.87, $n=14$; May—mean=8.36, SE=1.48, $n=23$; June—mean=7.64, SE=1.53, $n=21$).

The CV in the number of contacts was also different between months ($H_{4, 21}=11.46$; $p=0.022$; Table 1); the lowest values were observed in March and in the first half of April. The weekly variation in the mean number of contacts (the three observation points combined) is presented in Fig. 3.

The monthly variation pattern in the duration of the evening roding period was similar between the three observation points because POINT×MONTH interaction was not significant ($F_{8, 70}=1.12$, $p=0.359$). There were no significant differences in the mean value of duration between points ($F_{2, 70}=1.54$, $p=0.222$); with all observation points combined, values ranged from 3 to 58 min (mean=36 min, SD=12 min, $n=85$). Its weekly variation (Fig. 4) closely followed the variation in the number of contacts (see Fig. 2, $r=0.69$, $p<0.001$, $n=85$). There were significant differences between months ($F_{4, 70}=4.92$, $p=0.002$), which multiple comparisons showed to be caused by a lower duration of the

Fig. 2 Weekly variation in the number of contacts (woodcocks seen and/or heard) with roding birds at each observation point. When there are two observations in a week, the mean \pm SD is presented; otherwise, values correspond to a weekly observation. An *asterisk* points out the weeks when observations are absent because of bad weather



roding period in February (mean=26.67 min, SE=3.54 min, $n=10$), as compared with March (mean=42.32 min, SE=2.72 min, $n=18$) and April (mean=40.66 min, SE=2.44 min,

$n=21$). The other months presented intermediate values (May: mean=31.54 min, SE=2.56 min, $n=20$; June: mean=33.61 min, SE=2.97 min, $n=16$).

Table 1 Mean and standard deviation (SD) of the coefficient of variation (CV) of the number of contacts with roding birds by month (based on CV calculated for each week, the three observation points included) in Pico Island

	February	March	April		May	June
			(1)	(2)		
Mean	44.3	16.3	38.4	26.0	50.3	77.1
SD	19.0	10.4	16.7	7.9	23.9	25.7
N	3	5	4	2	5	4

(1) The 4 weeks included, (2) the 2 last weeks excluded

The evening roding period started and ended progressively later during the season, after the daily displacement of dusk, because of increasing day duration, throughout the breeding season (Fig. 5).

The number of contacts with roding birds minus the number of birds observed simultaneously was significantly correlated with the number of simultaneous contacts ($r=0.33$, $p=0.014$; $n=55$); that is, as the number of contacts with roding birds increased, the frequency of registrations corresponding to two or more birds observed simultaneously also increased.

Annual variation in roding intensity

The annual variation in the number of contacts with roding birds at Candelária and Ribeira das Calhetas is presented in Fig. 6. Unfortunately, after 2003, only one visit per point was made each year. Thus, considering only the years 2001, 2002 and 2003, the interaction POINT×YEAR was not significant ($F_{2, 26}=0.16$, $p=0.856$), which suggests that both areas presented a similar pattern of annual variation in the number of roding contacts. Although a trend of decline in the number of contacts after a hunting year was apparently visible in both locations, there were no differ-

ences between years ($F_{2, 26}=2.25$, $p=0.125$). The difference in roding intensity between the two points was significant ($F_{1, 26}=4.78$, $p=0.038$), with Candelária presenting higher values of contacts.

Sex and age ratio among collected birds

Among birds bagged during each of the three hunting seasons (Table 2), there was no significant difference in the number of males and females. In 2002 and 2004, only among females, the number of adult birds was significantly greater than the number of yearlings ($\chi^2_1 = 11.17$, $p<0.001$ and $\chi^2_1 = 4.05$, $p=0.044$, respectively). The number of yearlings per adult female was 0.63 in 2002, 2.10 in 2003 and 1.07 in 2004.

Among birds collected during the winter, there was also no significant difference in the number of males and females in each of the two periods considered (Table 2). The number of yearlings per adult female was 1.83 in winter 2000–2001 and 2.20 in winter 2001–2002. The altitudes at which these birds were collected were significantly lower than the altitudes at which birds were bagged during the hunting season ($U=426.5$, $p<0.001$; Fig. 7). However, with all data combined, the altitudes at which adult (mean=693.2 m, SE=27.2 m, $n=47$) and yearlings (mean=663.9 m, SE=29.7 m, $n=36$) were collected were not significantly different ($U=770$, $p=0.476$).

Discussion

In other Eurasian Woodcock populations (Hirons 1983; Marcström 1988, 1994; Ferrand 1989, 1993; Sandakov 2004), the number of contacts with roding birds in a particular area increased throughout the breeding season, peaking in May and June. Therefore, the best period to

Fig. 3 Weekly variation in the number of contacts with roding birds (the three observation points combined; values: mean±SE; sample size above x-axis)

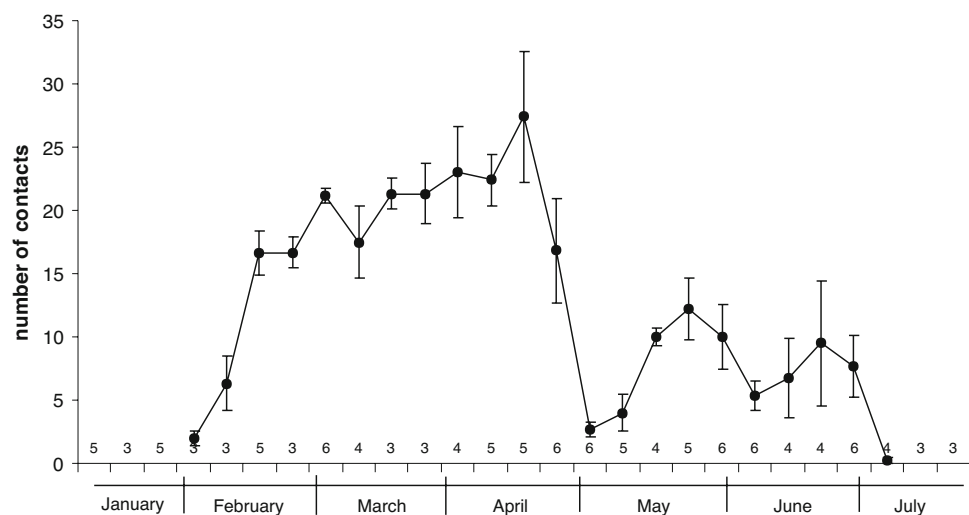
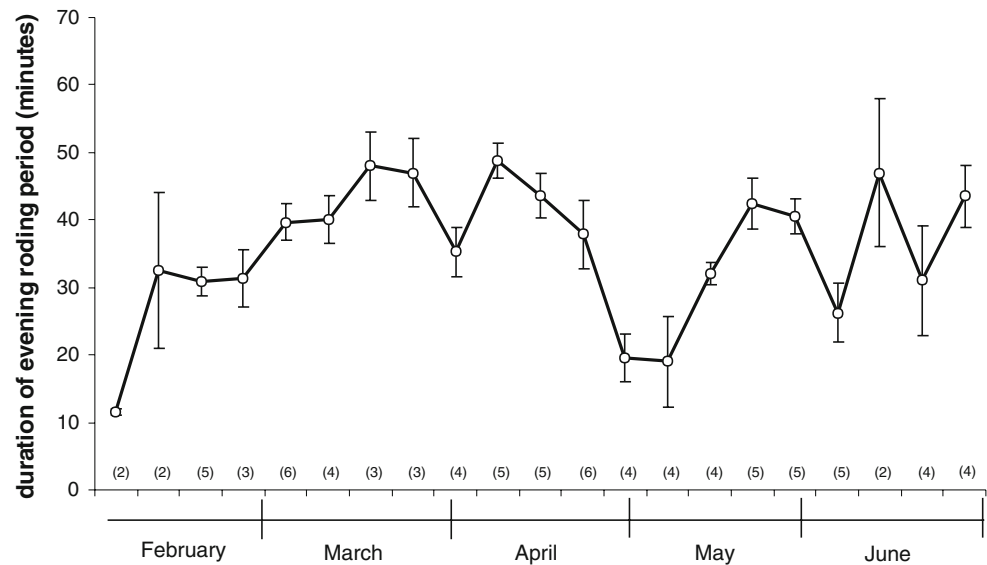


Fig. 4 Weekly variation in the duration of evening roding period (time elapsed between the first and the last contact; values: mean \pm SE), the three observation points combined. Sample size shown in parentheses



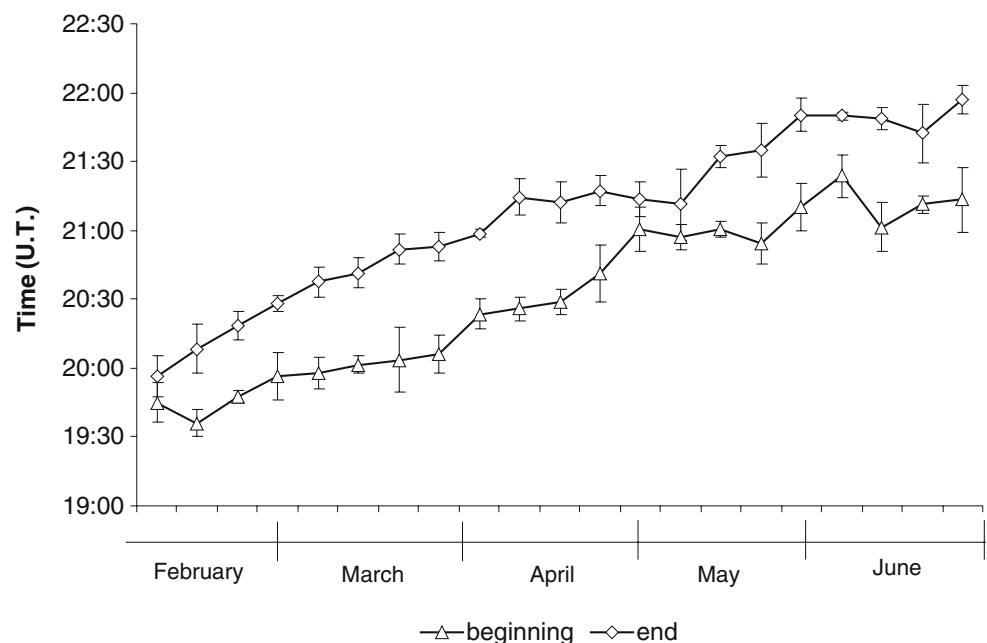
survey roding males is considered to be between May and June. In Azores, assuming that woodcock behaviour is similar in all the islands of the archipelago (no differences are expected in the annual life cycle), the survey of roding birds should be performed between the beginning of March and middle of April. During this period, the roding activity is more intense (higher number of contacts with roding birds), it is rather stable and the duration of the evening roding period is highest. Although results lack confirmation for Madeira and Canary archipelagos, we predict that their behaviour would be at least more similar to Azores populations rather than to continental populations.

In Pico Island, the duration of the evening roding period seems to be limited to a maximum value of about 1 h. In

other European locations, this duration progressively increases until it reaches maximum values in June (frequently more than 2 h; sometimes up to 3 or 4 h), almost at the end of the roding season (Ferrand 1993; Hirons 1983; Fokin and Blokhin 2000; Sandakov 2004). This is probably due to variations in the duration of the twilight period related with latitude (longer twilight periods at higher latitudes).

Several studies have revealed that after finding a receptive female, the male woodcock stays with her for some days, until egg laying, before resuming roding flights (Hirons 1983, 1987; Ferrand 1989). Additionally, in a study with radio-marked males, Hirons (1983) observed that they have displayed throughout the entire breeding season. The

Fig. 5 Weekly variation in the time of beginning and end of evening roding period (mean \pm SD), the three observation points combined. Time: Universal Time (U.T.)



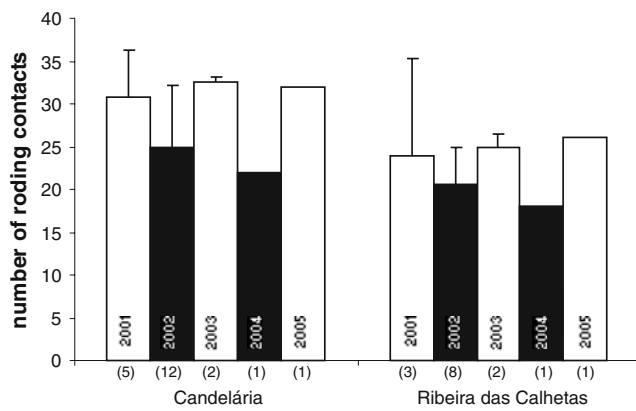


Fig. 6 Annual variation in the number of contacts with roding birds at two observation points, surveyed between March 1 and April 15, from 2001 to 2005. Number of visits in *parentheses*; when greater than one, the presented value corresponds to the mean number of contacts (\pm SD). For woodcock hunting, two major areas are considered, and annually they permute in permission to hunt woodcocks (for details, see Machado et al. 2006). The two observation points are in the same area. *Columns in white*: values obtained after a non-hunting season; *columns in black*: values obtained after a hunting season

weekly variation in the mean number of contacts observed in this study follows closely the distribution of clutches (first egg dates) estimated by Machado et al. (2006) also for Pico Island. These authors estimated that the highest number of clutches occurred in the second half of March and a second peak seemed possible in May, but data were scarce. The total time span between laying and raising the young until their independence is less than 2 months; for regions where the breeding periods stretches over 4 or 5 months, a second clutch can theoretically be laid (Ferrand and Gossmann 2001). Therefore, the decrease in the number of contacts observed between April and May in Pico Island could be explained by an increase in the number of females available for pairing (after a first major laying period), with the consequent increase in the number of pairs in the ground. The reinitiation of roding activity by males after clutch events could explain the new increase in the number of contacts registered in May. These results may

Table 2 Number of yearlings (Y) and adults (A) in each sex, among birds bagged during hunting season (October to November) along 3 years and among birds collected during the winter

Hunting season			Winter		
	Females (Y/A)	Males (Y/A)		Females (Y/A)	Males (Y/A)
2002	5/24	10/18	2000–2001 ^a	6/6	5/8
2003	17/20	25/26	2001–2002 ^b	6/4	5/2
2004	5/15	11/13			

^a December 2000 to March 2001

^b January to March 2002

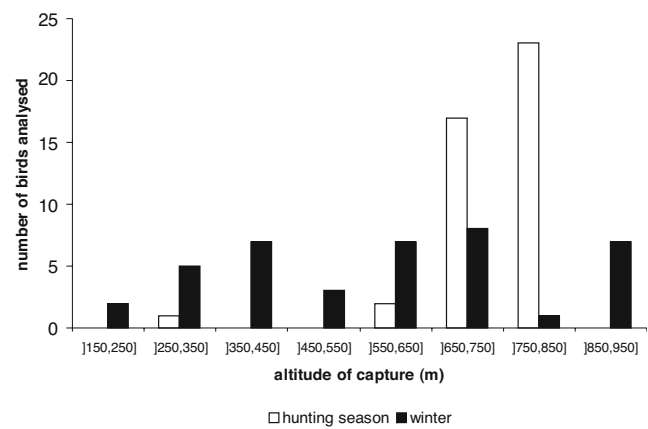


Fig. 7 Frequency distribution of birds according to altitude intervals of capture by different methods: hunting season—birds bagged during 2002 hunting season ($n=43$); winter—collected for the study on the adequacy of the hunting season (Machado et al. 2006; $n=40$)

thus suggest the occurrence of second broods, as most replacement nests would be expected in late April. In other European regions (like Ireland, Britain, France and North of the Iberian Peninsula), where a fraction of the individuals is sedentary (Cramp and Simmons 1983, Ferrand and Gossmann 2001), the same phenomenon could also be occurring. The movements of the long-distance-migrating birds could be ‘masking’ a variation pattern similar to that observed in Pico Island. For Russia, Fokin and Blokhin (2000) also appeal to second broods to partially explain a peak in roding intensity after mid-June. Hoodless and Coulson (1998), based on data on first-egg dates, also suggest that a proportion of female woodcock may be double-brooded in Britain. As stated by these authors, the monitoring of a large sample of radiotagged females is the only means of resolving this question.

Despite the low number of visits in some years and the absence of significant differences between years (which can be regarded as a consequence of stability in population size during the study years), the number of contacts with roding birds at Candelária e Ribeira das Calhetas tended to decline after a hunting year and to rise after a non-hunting year, a suggestion that the survey method is sensible to annual fluctuations, in this case mainly because of hunting.

Assuming that the hunting method did not influence the sex ratio among bagged birds, the results suggest that both sexes are equally represented in the woodcock population. This is important because the fraction of the population accessed by the survey of roding birds is the male fraction, and observed fluctuations during the years by this method can be extended to the female fraction.

Given the apparent low predation pressure in these islands, the adult life expectancy can be higher than the estimated for continental Europe namely, in France: 1.25 years (Tavecchia et al. 2002). This could partially explain the higher percentages of adult birds observed on

some occasions namely, among birds bagged during two hunting seasons. Additionally, from studies in continental Europe (Fadat 1995), we know that adult birds can be more numerous in areas with better conditions (abundant food and cover), while young birds occupy poorer, marginal areas, mainly during the winter; Pico hunters know very well the habitat, and they seem to search places at higher altitudes, where relative humidity is higher and food (earthworms) could be more abundant; however, apparently, the frequency of adult/yearling birds does not depend only on the altitude. Because of these factors, hunting results should be carefully analysed.

In summary, the results of the present work suggest that the survey of roding birds is a useful tool for monitoring woodcock breeding populations also in these insular regions. A monitoring scheme, based not only in the roding survey but also in the analysis of hunting results, may be crucial to establish sustainable management plans and should be extended to the other islands of the Azorean archipelago.

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