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Spring to autumn home range and habitat use of a high density population of the grey partridge (*Perdix perdix*) in Praha, Czech Republic

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A b s t r a c t . A study of home range and habitat use was carried out on grey partridge (*Perdix perdix*) in a high density population (24–33 pairs /km^2) in the south-west part of Praha, Czech Republic from 1997 to 1999. Radiotracking of individual partridge was used in the study (n = 11). Breeding period (March – June 15) and post-breeding period (June 16 – October) were analysed separately. Home range size (minimum convex polygon 95%) in the breeding period averaged 3.7 ha with a significant increase up to 8.7 ha in the post-breeding period. The majority of partridge ranges were located within dominant crop fields and idle habitats (unmanaged early stages of plant succession) referred to as weeds. Both high population density and small individual home ranges may result from the wide availability of weeds, whose attractiveness was probably due to availability of nesting sites, sufficient food supply for both partridge chicks and adults and adequate escape cover. Despite a high population density, there is an indication of little home range overlaps between pairs during the breeding period.

Key words: grey partridge, radiotracking, compositional analysis, habitat preference, weed habitats, agricultural landscape

Introduction

The grey partridge (*Perdix perdix*) population has suffered a large decline throughout Europe, beginning in the 1950s (e.g. P o t t s 1986, A e b i s c h e r & K a v a n a g h 1997). Although numbers still remain high in parts of Poland (e.g. three different regions in Poland up 19.6 pairs per km^2; P a n e k 1997a) and northern France (30 pairs km^{-2} or more still occur in many areas with prime habitats; R e i t z 1992), presently partridge populations are at less than 10% of their pre-1950s level in many European countries (A e b i s c h e r & K a v a n a g h 1997). The decline or disappearance of the traditional mosaic of mixed farming, decreased abundance of preferred insect prey for chicks, increased predation and the loss of nesting cover are considered to be among the most important causes of the dramatic decline of the species during the 20th Century (e.g. R a n d s 1986a, P a n e k 1992, A e b i s c h e r & K a v a n a g h 1997).

In the Czech agricultural landscape, partridge densities in the 1990s rarely exceeded 5 pairs km^{-2} (Š ť a s t n ý et al. 1997, Š á l e k & M a r h o u l 1999). Suprisingly, one of the highest density populations could be found in the periphery of Prague. The breeding density in this area varied locally from 24–33 pairs km^{-2} (Š á l e k & M a r h o u l 1999). The

population was neither hunted (since the 1970s) nor supported by releasing of hand-reared birds (members of local hunting club Řeporyje, pers. comm.).

The aim of the present study was to estimate home range size of grey partridges from pair formation to the post-breeding period and also to assess which habitat types play the most important role in this high density partridge population.

Study Area

The study was carried out in the southwestern part of Praha, Czech Republic (50°03'N, 14°18'E, 350 m a.s.l.) on an area of 150 ha. The site consisted of seven crop fields (51.7%), wide strips of weeds (29.8%), patches or strips of grass including one balk 10 x 1150 m (9.8%), technical elements such as roads, footpaths and some other artificial constructions (6.5%) and dispersed clusters of shrubs (2.2%). Fields were regularly farmed with a rotation of winter wheat (*Triticum*), lucern (*Medicago*), mustard (*Sinapis*) and spring cereal as the most important crops. Weed habitats were defined as unmanaged (idle) plant communities in early stages of succession, dominated by plant taxa such as *Agropyron, Anthemis, Arrhenatherum, Artemisia, Atriplex, Calamagrostis*, *Chenopodium, Daucus, Elytrigia*, *Lotus, Medicago, Melilotus*, *Rumex, Taraxacum, Tripleurospermum, Tussilago*, among many others. Weed habitat consisted mainly of land put aside by city planners for future developments such as shopping centres or roads, located mostly along fields in indiscrete patches 100–170 m in a width and 330, 370 and 780 m in a length. The study site was located in the vicinity of a large appartment-block and therefore highly disturbed by humans when walking and/or exercising their dogs. Predators such as marten (*Martes* sp.), fox (*Vulpes vulpes*), marsh harrier (*Circus aeruginosus*), magpie (*Pica pica*), goshawk (*Accipiter gentilis*) and sparrowhawk (*A. nisus*) regularly hunted in the study area and occasionally attacked or killed partridges (pers. obs.).

Material and Methods

Collection of data

In the years 1997–1999, 11 partridges (3 males and 8 females) were captured and necklace radiotransmitters (TW-4, Biotrack, UK) weighing 6.5 g were fitted. This type of transmitter should have a minimum negative effect on behaviour and predation risk (Putaala et al. 1997), which is at its highest during the first week post-release (Carroll 1990, Kaiser 1999).

Radiotagged partridges were monitored once every 6–8 days from March to October to record their breeding status, location and habitat use. No specific time of day or weather condition was favoured. A wide-range receiver (AR 8000) and hand-held Yagi antenna were used. Locations (fixes) and habitats were recorded on aerial photo-maps. The location was estimated either from short distance (up to 50 m), triangulation, observation or as a result of flushing. Monitoring of individuals ceased following death of an individual or once battery life had ended.

Data analyses

Two study periods were defined following Hudec & Černý (1977). The breeding period (March – June 15th) covered pair formation and other breeding stages until the date of young

fledging, whereas post-breeding (June 16th – October) represented the post-fledging time. The date of fledging may vary widely because of some earlier and namely frequent replacement clutches. Thus, if such an event was confirmed in any radiotracked partridge, the corresponding date of splitting between breeding and post-breeding periods was modified for respective individuals (no. 2, 5, 6, 10, 11, Table 1).

Before home range and habitat analysis, we excluded fixes representing females recorded when incubating the eggs to avoid autoreplication of nesting site and nesting habitat. Then we tested the number of fixes collected for each individual in order to examine how the range area changes as successive fixes are added and whether these numbers are sufficient to describe range size (incremental area plots; K e n w a r d 1996). We used 95% Minimum Convex Polygons (MCP) to define the home range (N e u et al. 1974). Span (of a range), defined as the maximum diagonal dimension of a polygon (K e n w a r d 1996), was also calculated.

When a female moved to renest after predation of her first clutch, the time periods were analysed separately and then pooled to calculate the total home range area (female no. 6). This avoided inclusion of the distance moved between the two nesting sites.

Habitat use was investigated by compositional analysis (A e b i s c h e r & R o b e r t s o n 1992, A e b i s c h e r et al. 1993) in which overall selection of habitats may be tested by Wilk's lambda statistics in multivariate analysis of variance (MANOVA). Zero use of available habitats, which were not used by individual partridges, was substituted by 0.1% proportion of use as a zero denominator in the log-ratio transformation is invalid (A e b i s c h e r et al. 1993). If preferential selection of any habitat was indicated, then contrasts comparing particular habitats were conducted using t-tests (M i l l s p a u g h & M a r z l u f f 2001). For all statistical analyses, we used S-PLUS® (1999) software.

Results

H o m e r a n g e s s i z e

During the breeding period, 192 fixes from 11 radiotagged partridges were recorded (Table 1). Each fix recorded per individual was separated from the next by an average of 6 days. Calculated home range sizes were not affected by the number of fixes in each sample ($r = 0.12$, $n = 11$, $P = 0.7$). Mean area of home ranges was 3.73 ha (SD = 3.02 ha, n = 11).

During the post-breeding period, 88 fixes from 6 radio-tracked partridge (female no. 11 was excluded due to small sample size, see Table 1) were recorded in 7 – days intervals per bird on average. Home range sizes were also unaffected by the number of fixes in each sample ($r = 0.3$, $n = 6$, $P = 0.5$). Mean home range size achieved 8.69 ha (SD = 4.32 ha, n = 6).

Home ranges in the post-breeding period were significantly larger than those in the breeding period ($t = 2.79$, $df = 15$, $P = 0.014$). This difference was not influenced by individual fix samples in either period (Mann-Whitney test: $U = 44.0$, $P = 0.2$). In fact, five of the six birds significantly enlargened their home ranges between the breeding and post-breeding periods (Wilcoxon test: $Z = 2.02$, $n = 5$, $P = 0.043$). In contrast, female no. 8's home range decreased between the breeding and post-breeding periods (from 9.0 ha to 5.2 ha). Home range size thus did not increase significantly between the breeding and post-breeding periods for the six birds for which we individually quantified seasonal home range size (Wilcoxon test: $Z = 1.57$, $n = 6$, $P = 0.116$; Table 1).

Table 1. Time periods, no. of fixes, home ranges size, span and history of radiotagged partridges in Praha, Czech Republic.

Bird no.	Sex	Period	Fixes (n)	Area (ha)	Span (m)	Note (fate etc.)
1	M	Jun 18 – Oct 28, 1997	16	8.38	452	Single male
		Mar 22 – Jun 15, 1998	27	1.35	791	Paired, no chicks observed
2	F	Jun 24 – Oct 28, 1997	15	16.57	566	Young reared
		Mar 22 – Jun 24, 1998	23	5.44	378	Nest destroyed
3	M	Mar 26 – June 15, 1998	21	1.52	187	Paired until May 15th
4	F	Mar 26 – May 15, 1998	14	1.36	338	Paired, died
5	M	Mar 26 – Aug 04, 1998	27	8.23	413	Young reared
		Aug 11 – Oct 16, 1998	10	9.56	434	Member of covey (up to 9 inds)
6	F	May 11 – Jun 02, 1998	6*	0.13	87	Nest predated
		Jun 05 – Jul 31, 1998	10*	0.62	116	Young reared
		Aug 04 – Sep 25, 1998	10	7.91	424	Member of covey (up to 26 inds)
7	F	Mar 03 – Jun 15, 1999	12	1.47	313	Nest predated
		Jun 25 – Oct 31, 1999	18	4.55	388	In a covey (up to 6 inds)
8	F	Mar 03 – Jun 15, 1999	12	8.98	469	Paired, breeding status unknown
		Jun 25 – Oct 31, 1999	19	5.15	413	Member of covey (up to 5 inds)
9	F	Mar 03 – Jun 15, 1999	15	6.39	408	Died after hatching of chicks
10	F	Mar 03 – Jun 07, 1999	11	1.96	242	Died after nest predation
11	F	Mar 03 – Aug 08, 1999	23	3.55	536	Young reared
		Aug 15 – Oct 01, 1999	7**	2.44	280	Member of covey (up to 13 inds)

* data pooled in calculation of total home range size ** excluded from the analysis due to small number of fixes

We found no difference in home range size between males and females in the breeding period (males: 3.7 ha, SD = 3.92, n = 3; females: 3.7 ha, SD = 2.94, n = 8; t = 0.02, df = 9, P = 0.9). Comparisons for post-breeding period are not presented as only data from two males was obtained.

Habitat use

Individual home ranges consisted particularly of two dominant habitats (Table 2), fields and weeds (89–97% combined). Compositional analysis indicated that habitat use within home ranges represented habitat composition of these ranges both in breeding and post-breeding periods. Also, habitat composition of individual home ranges did not differ from habitat availability in the study area during post-breeding period (Table 3). However, significant non-random habitat composition of home ranges, compared to habitat availability in the study area, was apparent during the breeding period (P = 0.031; Table 3). Comparing particular pairs of habitats, they can be ordered according to their preferential use: crop fields > shrubs > weeds > grass > technical elements; t-tests confirmed preferential selection of crop fields over grass (P = 0.014), shrubs over roads (P = 0.035) and crop fields over technical elements (P < 0.001).

Table 2. Estimated proportions (%), mean area (ha) and minima-maxima (min-max) for the home ranges of 11 radiotracked partridges within different habitats in Praha, Czech Republic.

	breeding period				post-breeding period			
Habitat	proportion (%)	mean area (ha)	min-max (ha)		proportion (%)	mean area (ha)	min-max (ha)	
Fields	72.3	2.72	0.24	8.57	68.7	6.03	3.03	11.30
Weeds	17.1	0.64	0	1.66	27.9	2.45	0	0.20
Grass	5.7	0.22	0	1.00	1.8	0.15	0	0.48
Shrubs	3.5	0.14	0	0.47	0.7	0.06	0	0.20
Others	1.4	0.05	0	0.33	0.9	0.09	0	0.32
Total	100	3.78			100	8.78		

Table 3. Wilks Lambda tests from compositional analysis of random habitat use by radiotagged partridges. (A) MCP home range vs total study area, (B) radio locations vs MCP home range.

	breeding period		post-breeding period	
	(A)	(B)	(A)	(B)
Wilks Lambda	0.257	0.376	0.082	0.088
P	0.031	0.104	0.156	0.169

Discussion

Partridge home range studies are limited in number (e.g., Blank & Ash 1956, Jenkins 1961, Smith et al. 1982, Church & Porter 1990, Birkan et al. 1992, O'Gorman 2001), and the results vary from several to hundreds of hectares. Within good

habitats (resulting in higher population densities of partridges), partridges may maintain smaller home ranges in comparison with poor habitats. Partridge densities reached 1 pair 1.6 ha^{-1} over large areas in East Anglia in the 1950s in what was regarded as some of the best partridge habitat in England (Blank & Ash 1956), corresponding to a breeding home range size of 1.35 ha. A high-density (70–80 pairs 1 km^{-1}) population near Winchester, South England, studied from 1953–1955, had a mean home range size of 3.04 ha, with the smallest 1.01 ha (Jenkins 1961). This is comparable with our study where partridge density was 1 pair per 3–4.2 ha (Šálek & Marhoul 1999), with a mean breeding period home range of 3.73 ha. In Ireland, the home range of partridges varied from 68–357 ha (MCP) outside the breeding season (O'Gorman 2001), and the population density was less than 1 pair 200 ha^{-1} (Kavanagh 1992, 1998). However, more detailed comparisons among various studies are difficult due to substantial differences in defining time periods, acquiring and analysing data (Smith et al. 1982, Harris et al. 1990, Birkan et al. 1992).

The density of the partridge population in the present study was higher than that known from the surrounding agricultural landscape in the Czech Republic (Šťastný et al. 1997, Šálek & Marhoul 1999) and probably also the majority of European farmland at present (cf. Aebischer & Kavanagh 1997). A comparison between population density (Šálek & Marhoul 1999) and mean home range size in the study area indicates that in spite of high breeding density, territories of neighbouring pairs settled in a habitat of good quality may be so small that they need not suffer from large overlaps. In an English study, small home range overlap led to less aggresive and less frequent attacks and thus less conspicuousness of adults (Jenkins 1961), which could result in lower predation risk (Beani & Dessì-Fulgheri 1998). Aggresive behaviour may be supressed by sufficient ground cover, which prevents birds from seeing each other (Jenkins 1961).

Both high population density and the small area of individual home ranges in our study area could be a result of sufficient availability of broadly favourable habitats. It is possible that a combination of open crop fields and weeds (both dominant habitats in the area and within home ranges) provide good opportunities for both pair formation and breeding of partridges. Although there was commonly observed foraging for food in fields during laying, incubation and post-hatching periods (pers. obs.), we assumed that the importance of this habitat increased, and particularly after the date of fledging when the birds have formed coveys and home ranges increase.

Weed habitat in particular provides seed, which is a major component of partridges' diet year-round (Janda 1966, Potts 1970). The plant cover within weeds consists of a mosaic of patches from bare soil to heavy cover. Bare soil enables easy detection of seeds dispersed on the ground, whereas sparse and high stalks allow relatively free locomotion and provide efficient hiding places not only against conspecifics but also from avian predators, which use visual cues when searching for prey. Also, dead grass in the plant sub-canopy offers wide opportunities for placing the nest (cf. Rands 1986b). Moreover, according to Panek (1997b) we can suppose that less disturbed weeds with permanent cover tend to increase the number of insects, which are an essential food supply for partridge chicks (e.g. Ford et al. 1938, Green 1984) and maintain higher reproductive success of birds. Idle habitats (old fields with undisturbed herbaceous cover, roadsides, farmsteads, shelterbelts, fencerows, weeds) are preferred by partridges during the breeding season in general (e.g. Smith et al. 1982, Church & Porter 1990).

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