National Quail Symposium Proceedings

Volume 6 Article 19

2009

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Recommended Citation

Kaiser, Wolfgang; Storch, Ilse; and Carroll, John P. (2009) "Habitat Use and Survival of Gray Partridge Pairs in Bavaria, Germany," *National Quail Symposium Proceedings*: Vol. 6 , Article 19.
https://doi.org/10.7290/nqsp066u5g
Available at: https://trace.tennessee.edu/nqsp/vol6/iss1/19

Habitat Use and Survival of Gray Partridge Pairs in Bavaria, Germany

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Gray partridge (*Perdix perdix*) habitat studies have been undertaken in a number of countries but have generally focused on winter and brood rearing. We monitored survival of grey partridge pairs relative to habitat during the breeding season. Our study area was located near Feuchtwangen in north-west Bavaria, Germany. During 1991 to 1994, we used compositional analysis to assess habitat with survival and year as covariates for 38 radio-tagged partridge pairs. Comparing study area habitat to habitats within pair home ranges, we found overall habitat use was non-random with no year effect but a significant effect of survival status. Stubble habitat ranked high for both survival categories, whereas those pairs where the radio-tagged bird died were more associated with meadow habitat. Comparing home ranges to individual radio locations, only surviving partridge used habitat differently from availability. Edge and set aside ranked high whereas meadow ranked low in usage. Our results suggest differences between habitats of partridge which died versus those that survived during breeding season. At the landscape level, association with meadow habitat suggests that it may provide cover but may also support predators. Within home ranges, we see edge and set aside possibly providing more cover diversity, suggesting predation avoidance for those that survived. Our data suggests that late winter and early spring periods, where survival may impact numbers of adults going into the breeding season and ultimately recruitment, are also crucial.

Citation: Kaiser W, Storch I, Carroll JP. 2009. Habitat use and survival of gray partridge pairs in Bavaria, Germany. Pages 172 - 177 in Cederbaum SB, Faircloth BC, Terhune TM, Thompson JJ, Carroll JP, eds. Gamebird 2006: Quail VI and Perdix XII. 31 May - 4 June 2006. Warnell School of Forestry and Natural Resources, Athens, GA, USA.

Key words: agriculture, farming, habitat, pairs, survival

Introduction

Long-term decreases in numbers of gray partridge, *Perdix perdix*, in the hunting districts around Feuchtwangen, North Bavaria, Germany motivated the "Hunting Society of Feuchwangen" to carry out a habitat management program for gray partridge since 1985. Gray partridge habitat studies have been undertaken in a number of countries but have generally focused on winter and brood rearing (Potts 1986, Carroll 1990, Carroll et al. 1995, Church and Porter 1990, Kaiser 1998). This period is considered critical as winter family groups and coveys break up and pairs are formed; dispersing to nesting areas (Potts 1986). Subsequent recruitment will then depend in part on dispersal and survival of those breeding pairs (Potts 1986). Previously, Smith et al. (1982) and Church and Porter (1990) evaluated habitat use by breeding pairs.

In addition, there have been few studies linking habitat and individual survival. For example, Panek (1990) found in Poland during winter that coveys with home ranges closer to forests had higher mortality rates. However, in Bavaria, Kaiser (1998) found no relationship between habitat use and survival among winter coveys.

As part of a larger study to assess the effects of different types of habitat management on partridge populations and ecology, we monitored survival of grey partridge pairs relative to habitat during the breeding season.

Study Area

Our study area was located near Feuchtwangen (District Ansbach) in north-west Bavaria, 70 km

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Table 1: Log-ratio differences and rankings of individual habitat comparing 2^{nd} order habitat use (study area versus home range) for surviving partridge pairs ($n = 26$) during breeding season in Bavaria, Germany. For rankings, a larger number means that the habitat was most selected.

		sa	**st**	**ed**	**wc**	**ra**	**pf**	**me**	**rank**
set-aside	mean		-0.199	0.67	0.374	1.124	0.251	1.268	**5**
	SE		0.698	0.321	0.378	0.477	0.396	0.397	
	p		0.781	0.057	0.349	0.048	0.529	0.011	
stubble	mean	0.199		0.646	0.827	1.115	0.92	1.107	**6**
	SE	0.698		0.386	0.393	0.516	0.374	0.389	
	p	0.781		0.12	0.061	0.028	0.028	0.018	
edge	mean	-0.67	-0.646		-0.015	0.189	-0.02	0.426	**2**
	SE	0.321	0.386		0.235	0.274	0.253	0.212	
	p	0.057	0.12		0.944	0.501	0.928	0.048	
winter cereal	mean	-0.374	-0.827	0.015		0.209	-0.005	0.442	**3**
	SE	0.378	0.393	0.235		0.343	0.17	0.267	
	p	0.349	0.061	0.944		0.565	0.974	0.083	
rape	mean	-1.124	-1.115	-0.189	-0.209		-0.321	0.245	**1**
	SE	0.477	0.516	0.274	0.343		0.361	0.336	
	p	**0.048**	**0.028**	0.501	0.565		0.387	0.496	
plowed field	mean	-0.251	-0.92	0.02	0.005	0.321		0.447	**4**
	SE	0.396	0.374	0.253	0.17	0.361		0.28	
	p	0.529	**0.028**	0.928	0.974	0.387		0.135	
meadow	mean	-1.268	-1.107	-0.426	-0.442	-0.245	-0.447		**0**
	SE	0.397	0.389	0.212	0.267	0.336	0.28		
	p	**0.011**	**0.018**	**0.048**	0.083	0.496	0.135		

south-west of Nurnberg, Germany. It was situated between 427 m and 514 m above sea level. Of the total area in the district of Ansbach, 29% was covered by small woodlands and 60% was private farmland. Main agricultural crops were winter cereals (40%), maize, rape, and root crops (21%). About 39% of farmland consisted of permanent grassland (Reider 1984). Average field size was 1.5 ha and the length of permanent cover along ways, hedges and ditches was 18 km/km^2. Spring densities of partridge were 4-8 pairs/km^2 during 1992-1994 (Kaiser 1998).

Methods

During 1991 to 1994, 136 partridges were captured in autumn using mist nets (5 m x 18 m, mesh-width 3 x 3 cm). The birds were equipped with 7 g necklace radio tags (TW-3, Biotrack Co., UK) with a life expectancy of 7-8 months and a range of 800 - 1000 m. From capture to pairing, partridge were tracked using a Televilt RX-81 receiver and a two-element Yagi aerial. Partridge were located daily, but to avoid bias due to time of day, radiolocations were sampled throughout the day. We used "homing" techniques to verify individual locations. This allowed us to accurately place each location in one of the following habitat types: set-aside (SA; self-regenerated), cereal stubble (CS; also maize stubble), edge (ED; hedges, ways, ditches, field boundaries), oilseed-rape (RA), ploughed field (PF), permanent grassland (PG), and winter cereal (WC).

We used compositional analysis (Aebischer et al. 1993) to assess habitat with survival and year as covariates. We defined the breeding or spring season to encompass those dates during break up of win-

Table 2: Log-ratio differences and rankings of individual habitat comparing 2^{nd} order habitat use (study area versus home range) for partridge pairs ($n = 12$) that died during the breeding season in Bavaria, Germany. For rankings a larger number means that the habitat was most selected.

		sa	st	ed	wc	ra	pf	me	Rank
setaside	mean		-1.951	-0.368	-0.811	-1.384	-1.29	-0.915	**6**
	SE		0.318	0.682	0.573	1.537	0.701	0.704	
	p		0.033	0.594	0.212	0.527	0.103	0.236	
stubble	mean	1.951		1.609	1.473	0.608	1.036	1.19	**5**
	SE	0.318		0.58	0.313	1.306	0.399	0.504	
	p	**0.033**		0.043	0.015	0.73	0.033	0.053	
edge	mean	0.368	-1.609		0.27	-0.053	-0.136	-0.348	**3**
	SE	0.682	0.58		0.39	0.704	0.367	0.102	
	p	0.594	**0.043**		0.524	0.913	0.71	0.008	
winter cereal	mean	0.811	-1.473	-0.27		-0.865	-0.445	-0.636	**2**
	SE	0.573	0.313	0.39		0.636	0.095	0.344	
	p	0.212	**0.015**	0.524		0.21	0.001	0.08	
rape	mean	1.384	-0.608	0.053	0.865		0.474	-0.224	**4**
	SE	1.537	1.306	0.704	0.636		0.513	0.685	
	p	0.527	0.73	0.913	0.21		0.429	0.713	
plowed field	mean	1.29	-1.036	0.136	0.445	-0.474		-0.211	**0**
	SE	0.701	0.399	0.367	0.095	0.513		0.319	
	p	0.103	**0.033**	0.71	**0.001**	0.429		0.607	
meadow	mean	0.915	-1.19	0.348	0.636	0.224	0.211		**1**
	SE	0.704	0.504	0.102	0.344	0.685	0.319		
	p	0.236	0.053	**0.008**	0.08	0.713	0.607		

ter coveys to nesting. We analyzed habitat at two scales encompassing Johnson's (1980) 2^{nd} and 3^{rd} orders. For 2^{nd} order analysis we compared the proportions of habitats for the whole study area with those within convex polygon home ranges. For 3^{rd} order analysis we compared proportions of habitats within convex polygon home ranges to individual radio locations.

Results

We monitored survival status and habitat of 38 grey partridge pairs during 1992-1994 (Figure 1a). Comparing study area habitat to habitats within pair home ranges, we found overall habitat use was non-random ($\lambda = 0.4234, n = 38, P < 0.001$). We found no year effect ($\lambda = 0.629, P = 0.14$), but a significant effect of survival status ($\lambda = 0.5855, P = 0.005$) on habitat use (Figure 1b). Habitat proportions within home ranges compared to individual locations were different ($\lambda = 0.3820, P = 0.008$). We found year effect to be close to significant ($P = 0.05$) and a survival effect ($P = 0.01$). Comparing study area to home ranges, both surviving and non-surviving partridge used habitat differently from availability ($\lambda = 0.4388, n = 26, P = 0.005$ and $\lambda = 0.0769, n = 12, P = 0.001$, respectively). At this level, stubble ranked high for both survival groups, whereas those pairs where the radio-tagged bird survived were more associated with set aside and those that died more associated with meadow habitat (Tables 1 and 2). For both survival groups cereal, edge, and rape, ranked low.

Comparing home ranges to individual radio locations, only surviving partridge used habitat dif-

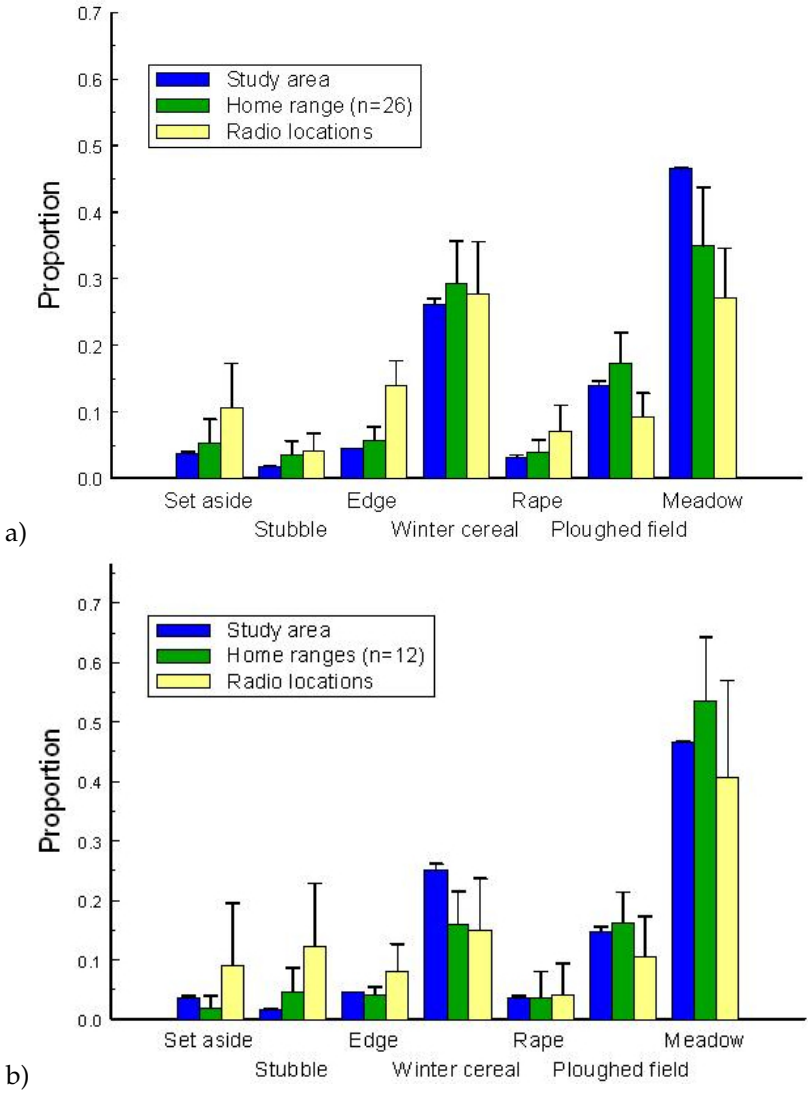

Figure 1: Habitat proportions (+SE) available on the study area, within convex polygon home ranges, and for individual radio locations of surviving gray partridge pairs (a) and those that died (b) during breeding season in Bavaria, Germany.

ferently from availability ($\lambda = 0.2004, n = 26, P < 0.001$, and $\lambda = 0.2632, n = 12, P = 0.69$, respectively). At this level of analysis (habitat within home ranges to individual radio locations), we found that edge and set aside ranked high, whereas meadow and cereal ranked low for surviving pairs (Table 3).

Discussion

Habitat associations relative to survival of gray partridge have been demonstrated during winter (Panek 1990, Carroll et al. 1995) and during brood rearing (Potts 1986). Our habitat results were similar to Church and Porter (1990) who found pairs selecting for grain stubble due to waste grain, which is found in abundance in these habitats. They also found that idle upland habitat, dominated by old

Table 3: Log-ratio differences and rankings of individual habitat comparing 3^{rd} order habitat use (home range versus radio locations) for surviving partridge pairs ($n = 26$) during breeding season in Bavaria, Germany. For rankings a larger number means that the habitat was most selected.

		sa	**st**	**ed**	**wc**	**ra**	**pf**	**me**	**rank**
setaside	mean		0.774	-0.024	1.283	0.098	2.045	1.323	**5**
	SE		0.469	0.401	0.191	0.606	0.297	0.241	
	p		0.142	0.951	0.001	0.873	0.002	0.002	
stubble	mean	-0.774		-0.952	0.446	-0.369	1.366	0.524	**3**
	SE	0.469		0.29	0.298	0.629	0.303	0.291	
	p	0.142		0.005	0.148	0.54	0.003	0.1	
edge	mean	0.024	0.952		1.086	0.251	1.545	1.111	**6**
	SE	0.401	0.29		0.301	0.412	0.288	0.277	
	p	0.951	**0.005**		0.002	0.548	0.001	0.001	
winter cereal	mean	-1.283	-0.446	-1.086		-1.168	0.44	0.015	**2**
	SE	0.191	0.298	0.301		0.394	0.248	0.2	
	p	**0.001**	0.148	**0.002**		0.019	0.096	0.944	
rape	mean	-0.098	0.369	-0.251	1.168		1.437	0.97	**4**
	SE	0.606	0.629	0.412	0.394		0.396	0.353	
	p	0.873	0.54	0.548	**0.019**		0.003	0.017	
plowed field	mean	-2.045	-1.366	-1.545	-0.44	-1.437		-0.514	**0**
	SE	0.297	0.303	0.288	0.248	0.396		0.203	
	p	**0.002**	**0.003**	**0.001**	0.096	**0.003**		0.016	
meadow	mean	-1.323	-0.524	-1.111	-0.015	-0.97	0.514		**1**
	SE	0.241	0.291	0.277	0.2	0.353	0.203		
	p	**0.002**	0.1	**0.001**	0.944	**0.017**	**0.016**		

field herbaceous cover, was selected preferentially. Smith et al. (1982) found that what they termed "idle" habitat was also preferred by pairs. However, on their study area in South Dakota, these habitats were usually grassy edges along crop fields, roads, and shelterbelts. These studies in both Europe and North America all suggest that habitat use during breeding season is driven by proximity to nesting sites. In both of those studies (Smith et al. 1982, Church and Porter 1990), home range and radio-location data were not divided. Our finding of greater selection of edge habitats and set aside among surviving pairs suggests that this trend is similar on our study area.

Our analysis of survival relative to habitat of breeding pairs suggests that there were significant differences between habitats of breeding individuals which died versus those that survived during breeding season. These differences are likely a function of landscape and local effects of predator distribution relative to land use. The association between partridges that died and meadow habitat suggests that this permanent habitat likely provides some cover and is used commonly by partridge, but may also be core habitat for both mammalian and avian predators. Surviving pairs were more associated with herbaceous vegetation in set aside, which is a more ephemeral habitat and may not support the types of predators found in more permanent habitats. At the local level, we see edge and set aside possibly providing more cover diversity, again suggesting predation avoidance options for those that survived.

Breeding habitat is often ignored in research on partridge ecology with more focus on winter and

brood habitat. Our data suggest that habitat relative to survival during this period may impact numbers of adults going into the nesting season.

Acknowledgments

We wish to thank the Bavarian State Ministry of Agriculture for funding. Many farmers and hunters provided access to their land for the study. We also acknowledge funding provided to JPC by the University of Frieburg which allowed the authors to collaborate on this project.

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