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Short communication

Home range size, movements, and habitat utilization of three male European wildcats (*Felis silvestris* Schreber, 1777) in Saarland and Rheinland-Pfalz (Germany)

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Although several radio-telemetry studies of European wildcats have been conducted (e. g. Corbett 1979; Stahl et al. 1988; Liberek 1999), systematic investigations on European wildcats are lacking in Germany. Due to a population size of approximately 1000 individuals (F. Raimer pers. comm.) and the connection to wildcat populations in neighbouring France and Luxembourg, the population in Rheinland-Pfalz is of great importance for the conservation of wildcats in central and western Europe. Therefore, a radio-telemetry study was conducted in Saarland and adjacent parts of Rheinland-Pfalz, to assess home range size, movements and habitat utilization of European wildcats in this region.

The study area encompassed approximately 130 km^2 in northern Saarland and southern Rheinland-Pfalz, southwest Germany (6°55′ E, 49°36′ N). Elevation in the area ranges from 250 to 650 m. Precipitation is greatest at high elevations and ranges annually from 700 to 1000 mm and temperatures vary from –16.5 °C to over +30.0 °C (Fischer 1989). A mean snow depth of 10 cm is recorded for 10 to 80 days. Approximately 39% of the study area was forested. The dominate native tree was red beech (*Fagus sylvatica*), but spruce (*Picea abies*) and Douglas fir (*Pseudotsuga menziesii*) were commonly planted. At lower elevations agriculture was common and forest climax consisted of submontane beech-oak-forests (*Quercus petrea*). Current agricultural practices result in many fallow fields and meadows.

Over the duration of the study, 3 male wildcats were caught in box traps, sedated with a Ketamin/Xylazin-mixture (Hatlapa and Wiesner 1982), weighed, measured, and radiocollared (50 g; K. Wagener Cologne, Germany) (Tab. 1). Approximate age was estimated based on tooth succession and condition.

Wildcats were primarily located continuously during their main active period at night resulting in successful locations approximately once every 50 minutes. Accuracy of radio locations was evaluated under different habitat conditions, consistent with literature standards (White and Garrott 1990) and allowed to evaluate a habitat-specific telemetry error of 100 m. For home range analysis, locations were filtered for 2 hour intervals to equally distribute the data. Adaptive Kernel (AK) estimates (Worton 1989) of annual and seasonal home ranges were estimated using the program Ranges V (Kenward 1995). In addi-

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tion, minimum convex polygons (MCP) (Mohr 1947) were measured for comparison with previous research.

The area enclosed in the 95% AK contour was defined as the home range of an individual to exclude outliers. Core areas were defined as the area within the 50% contour. Seasonal delineations considered mating behaviour (Piechocki 1990) and prey availability (Sládek 1973) and included: winter mating season (January–March), spring (April–June), summer (July–September), and autumn (October–December). Over the duration of this study, M1 was monitored for 249 days, M2 for 49 days, and M3 for 266 days resulting in a total of 1276 relocations with 77% of the locations being recorded between 18.00 h and 07.00 h.

Minimum nightly movements were calculated by summing the distances between relocations of nights where cats were followed for ≥5 hours and both daily resting sites were recorded. The average observation time per night was 9.35 hours. (SD = 3.02) resulting in an average of 11 (SD = 4) successful locations per night.

Locations were imported into the Geographic Information System (GIS) MapGrafix (ComGrafix USA). Habitat use was determined using a circular buffer with a 100 m radius around the locations filtered for a 1 hour interval. Within this 3.14 ha buffer the extent of each habitat was recorded. When analyzing for seasonal habitat use, areas for each habitat category included in all locations were summed to equal the probability that a location was in a specific habitat category. Analysis of habitat utilization was restricted to M1 and M2 as digitized maps were unavailable for M3. Selection of habitat was assessed by comparing availability and use of habitat types within the total range (100% AK) of an individual following the method described by Neu et al. (1974). An $\alpha = 0.05$ was used to determine significance for tests of the null hypotheses.

Home range: The largest seasonal home range of 2515 ha was observed in winter 1996 for M2 (Tab. 1). Both M1 and M3 had their largest seasonal home ranges during spring. Seasonal home ranges during winter and spring were significantly larger than during summer and autumn (one tailed t-test, df = 6, $p = 0.025$). Accounting for the total number of relocations, annual home ranges were estimated to be 1407 ha for M1 and 1916 ha for M3, averaging 1662 ha. Core areas ranged from 92 to 460 ha. Spatial overlap between M1 and M2 during January and February 1996 was 224 ha. Therefore M1 shared 29% and M2 approximately 9% of its range. Core areas were used exclusively.

Nightly movements: The seasonal average of distances travelled per night ranged from 2.8 km during summer to 11.3 km during winter (Tab. 1). Over a period of 14 hours, the longest observed nightly movement was 13.3 km recorded for M2 in February 1996. Nightly movements during winter/spring averaged 5.5 km (SD = 2.6 km) and were significantly longer than movements during summer/autumn averaging 3.0 km (SD = 1.2 km) (one tailed t-test, df = 70, $p < 0.001$).

Habitat use and selection: More than 1 habitat category was found within the 100 m accuracy buffer around 74% of the locations of M1 and 65% of the locations of M2. Of these 85 and 79% included forest edge for M1 and M2 respectively. Of the locations encompassing only 1 habitat category, 96% were in forests. For both cats, 3 habitat types (forests, fields/meadows, riparian meadows) accounted for 86 to 91% of the relocations. Forests were used most intensively throughout the study period ranging from 50 to 55% of the locations. Fields/Meadows were used by M1 more intensively during winter and summer, riparian meadows were used most often in spring. Percentages of forested areas included in seasonal total ranges varied between 40 and 66%.

Habitat use was significantly different from expected for M2 during winter, showing preference for fields/meadows and avoidance for clearings ($\chi^2 = 30.41$, df = 4, $p < 0.001$) (Fig. 1). During the same period M1 used habitats proportionately to their occurrence ($\chi^2 = 4.52$, df = 4, $p = 0.34$). M1

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Table 1. Wildcats characteristics, home range sizes, and nightly movements

	Capture			Loss	Number of relocations		Home range in ha				Nightly movements in km		
							Adaptive Kernel			MCP			
	Collared	Age	Weight	Date/Status	Season	n	100%	95%	50% core area	95%	Complete nights (n)	Average	SD
M1	09. 01. 1995	adult,	5 250 g	29. 9. 1996	Winter	116	1 613	966	138	889	7	5.4	1.8
	24. 02. 1996	> 24	4 800 g	Unknown	Spring	208	3 475	1 806	457	1 744	25	4.1	1.6
		months			Summer	177	2 095	1 261	228	1 202	20	2.8	1.1
					Autumn	–	–	–	–	–	–	–	–
					Total	501	3 401	1 407	452	2 261	52	3.9	1.7
M2	12. 01. 1996	adult,	6 700 g	29. 2. 1996	Winter	99	3 343	2 515	177	1 718	4	11.3	1.8
		> 36		Starvation	Spring	–	–	–	–	–	–	–	–
		months			Summer	–	–	–	–	–	–	–	–
					Autumn	–	–	–	–	–	–	–	–
					Total	–	–	–	–	–	–	–	–
M3	22. 08. 1997	adult,	5 750 g	14. 5. 1998	Winter	113	3 513	1 779	231	1 453	6	4.8	3.0
		> 24		Unknown	Spring	68	2 536	2 342	460	1 764	4	6.6	1.4
		months			Summer	47	740	502	92	382	3	2.9	0.3
					Autumn	87	1 462	986	134	892	3	4.8	1.2
					Total	315	3 450	1 916	245	1 993	16	4.9	2.3

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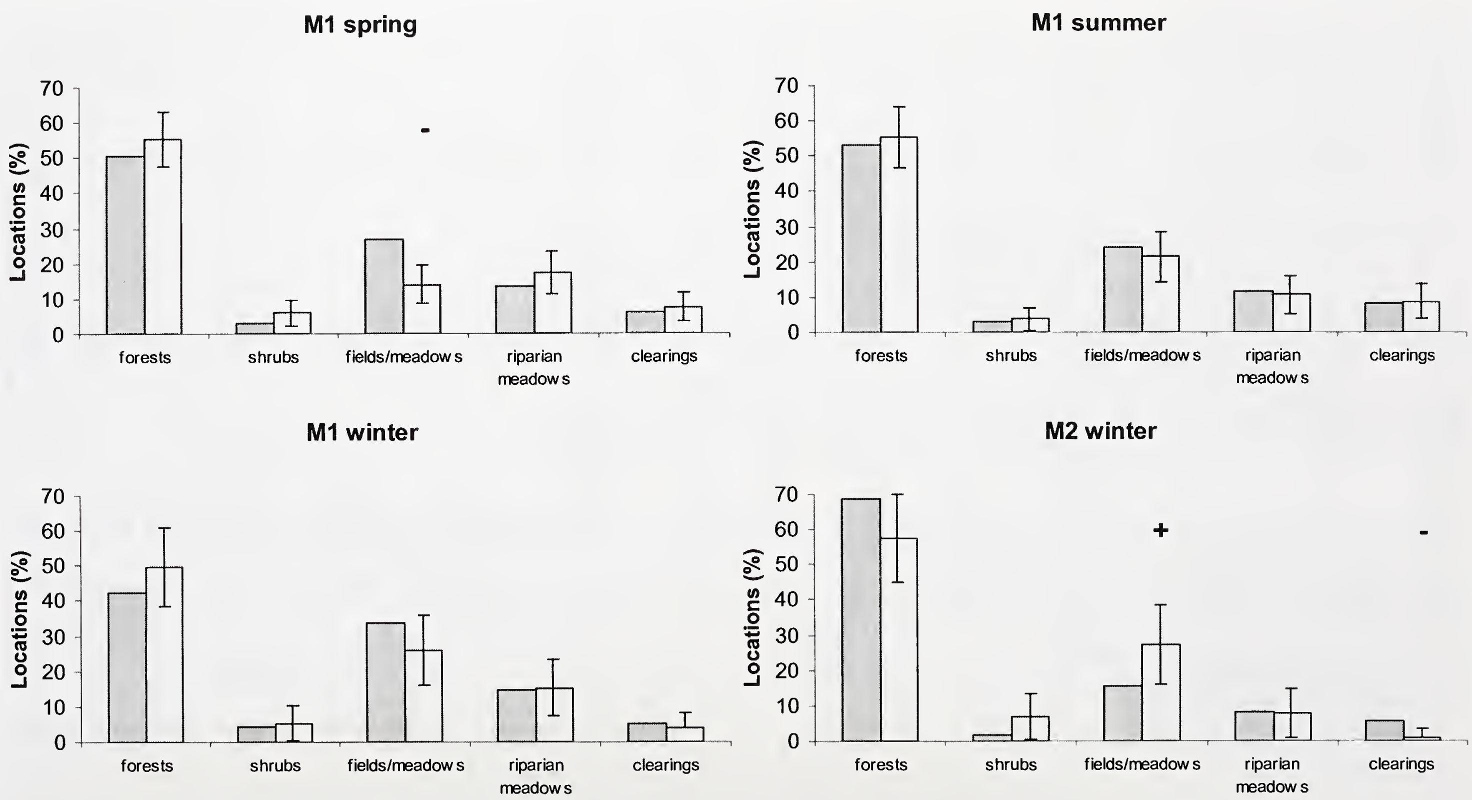

Fig. 1. Habitat selection M1 and M2; grey columns indicate avaibility within individual seasonal total range, white columns indicate habitat use, error bars indicate confidence intervals according NEU et al. (1974), ± = habitat use significantly different from expected.

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showed avoidance of fields/meadows in spring ($\chi^2 = 28.63$, df = 4, $p < 0.001$) and used habitats in proportion to their availability during summer ($\chi^2 = 1.75$, df = 4, $p = 0.78$).
The average annual home range size of 1662 ha in this study was larger than ranges reported for radiocollared male wildcats in previous studies (Corbett 1979; Stahl et al. 1988). However, MCP seasonal range sizes in this study were smaller than seasonal MCP range sizes recorded for male wildcats in Switzerland (Liberek 1999), indicating that home range sizes in male European wildcats vary under different ecological conditions. Use of home ranges is believed to be exclusive in areas where lagomorphs dominate the diet as opposed to exclusiveness only for animals of the same sex in areas where rodents dominate the diet (Stahl et al. 1988). As the energetic requirements of wildcats increase with the number of prey items required to fulfil their energy demand (Hemmer 1993), the observed differences in range sizes may be explained by differences in availability and abundance of prey.
First order selection (Johnson 1980) of areas inhabited by European wildcats have highlighted the importance of large forested areas with clearings interspersed to increase the amount of edge (e.g. Vogt 1985; Hemmer 1993). First order selection would be strongly influenced by persecution by people and resulting extirpation from large areas of suitable habitat.
Third order selection using radio-telemetry has been studied in east central France (Stahl 1986). Results of this study are consistent with Stahl (1986) with seasonal total ranges including 40 to 66% of forested areas showing the importance of cover to wildcats. Because 65 to 74% of the locations encompass more than 1 habitat category, the importance of habitat boundaries, especially forest edge was indicated. The animals studied showed individual and seasonal variation in habitat selection. The flexibility of wildcat habitat use during this study indicates the ability of wildcats to live in forested landscapes altered by humans and suggests that habitat may not be preventing wildcat recovery from low population numbers.

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