

The process of a wolf pack splitting in Białowieża Primeval Forest, Poland

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In 1998, the pack of 7 wolves *Canis lupus* Linnaeus, 1758, radio-tracked in Białowieża Primeval Forest, East Poland, split into 2 packs (2 and 5 wolves), when an 8-year-old alpha female ceased breeding. The two sister-packs subdivided their original territory, but their ranges overlapped extensively (49%) for one year after the split, except for May–June, when both new packs reared pups. We propose that food related factors could have been the ultimate cause of splitting of a large pack. In European temperate forests, pack size of 5–6 wolves is optimal for the consumption of the red deer *Cervus elaphus*.

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Introduction

The growth of a wolf *Canis lupus* Linnaeus, 1758, population happens by both an increase in pack size and increase in the number of packs in an area. Two main processes of new pack formation have been described (review in Mech and Boitani 2003). Pack budding happens, when a wolf disperses from its natal territory, pairs with a floater of the opposite sex, and set up a territory, often adjacent to or partly inside the natal territory of one of both dispersers. Pack splitting happens, when a large pack divides into about equal parts, subdividing their original territory. In North America, pack splitting occurs when large packs (14–15 wolves) divide into 2 or more groups (Meier *et al.* 1995, Hayes and Harestad 2000). In this note, we report the pack of 7 wolves that disintegrated when pair of wolves, both from the same pack, split from it and formed a new family. We discuss the ecological differences that regulate the size of wolf packs in Europe versus North America. We

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argue that pack splitting happens in smaller packs in Europe due to differences in ungulate prey.

Study area, methods and material

In 1994–1999, wolves were studied by radio-telemetry, snow tracking, and genetic analyses in the temperate woodlands of Białowieża Primeval Forest (BPF), located in eastern Poland and western Belarus (Jędrzejewska and Jędrzejewski 1998, Okarma *et al.* 1998, Jędrzejewski *et al.* 2000, 2002a). Wolves were live-trapped in nets (Okarma and Jędrzejewski 1997), immobilised with 1.2–1.8 ml of a xylazine-ketamine mixture (583 mg of Bayer's Rompun dissolved in 4 ml of Parke-Davis Ketavet 100 mg/ml), and were fitted with VHF radio-collars (Telonics Inc., AVM Instrument Company, and Telemetry Systems). In 1994–1997, three packs of 4–8 wolves inhabited the Polish part of BPF (600 km², 52°45'N 24°01'E). In the winter of 1997/1998, the pack Leśna split into 2 groups, Leśna I and Leśna II. Three females (Bura, Siwa, and Syta) were radio-tracked in the two packs. We located radio-collared wolves by triangulation 2–5 days per week by following forest roads with vehicle or bicycle. In addition, we conducted sessions of 2–9 days of continuous radiotracking, with locations taken at 15-min intervals. Observers followed the wolves from the mean distance of 0.94 km (SD 0.58) and the distance between wolf and observer had no significant effect on wolf activity (Theuerkauf and Jędrzejewski 2002). We estimated home range areas with the program Tracker (A. Angerbjörn, Radio Location Systems AB, Huddinge, Sweden) using standard Minimum Convex Polygons as the area measure.

Results

In summer 1996, the pack Leśna consisted of 8 wolves (including 3 young), the largest pack in our study (Jędrzejewski *et al.* 2002a). In spring 1997, a radio-collared, 7-year-old alpha female (Bura) entered her last breeding cycle. We estimated her age by tooth wear (Gipson *et al.* 2000). She bred for 3 years after being trapped in January 1995. Three pups were reared in summer 1997, and in autumn (November–December) the pack (7 wolves) was still together. Their annual home range in 1997 covered 303 km² (MCP100%). The MCP with 95% of location was 245 km², and the core area (MCP50%) was 78 km². We radio-tracked Bura and her subadult daughter Siwa. The pack contained at least another (non-collared) female, and a male with very dark, nearly black pelage (Czarny). The male was a member in pack Leśna since December 1997 but his relatedness to other pack members was unknown. In January 1998, Siwa and Czarny begin to separate from the pack, although they still contacted their pack-mates and sometimes used the same kills. At that time Siwa was in oestrus. In the other part of the pack, the second female overtook the role of an alpha female.

In March–April 1998, the two split groups were well separated, and by the end of April each selected a new den site, different from one used by Bura in previous years (Fig. 1). Both new packs reared pups in 1998. We saw 4 pups in Leśna I and 2 pups in Leśna II, at least one of Leśna II pups was still alive in early winter.

In 1998, Leśna I pack lost two females. Bura (aged 8 years) died in late summer, and the new alpha female was shot in late November in the borderland of the Belarussian part of the pack home range. In July–August 1998, we did not have any wolves radio-collared in the pack Leśna I. We captured and radio-collared a juvenile

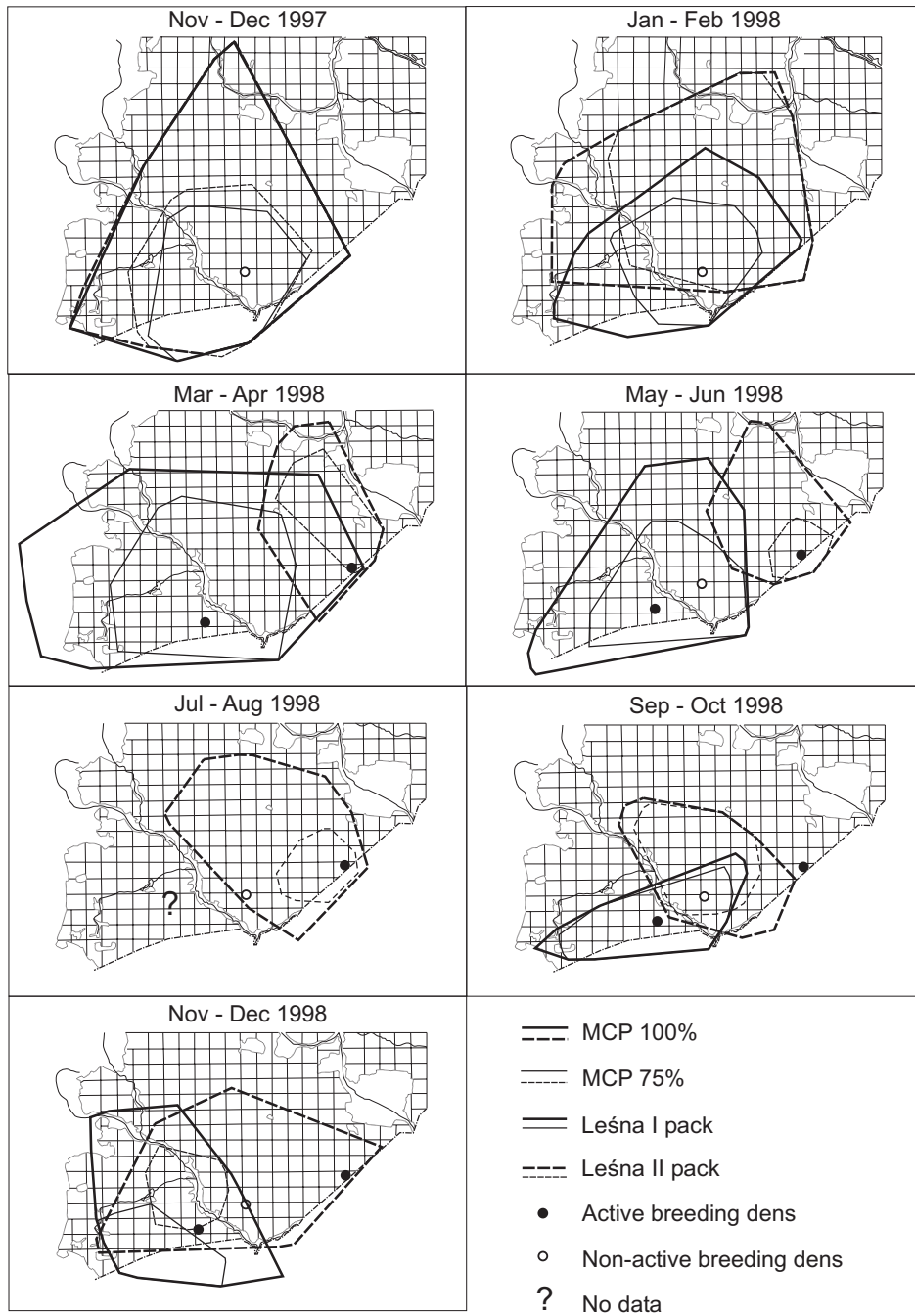


Fig. 1. Shifts of bimonthly ranges (Minimum Convex Polygons with 100% and 75% of locations) of two wolf packs, Leśna I and Leśna II, in the process of their splitting from one maternal pack in Białowieża Primeval Forest, E Poland. MCP100% ranges based on 348 to 1048 radio-telemetry locations.

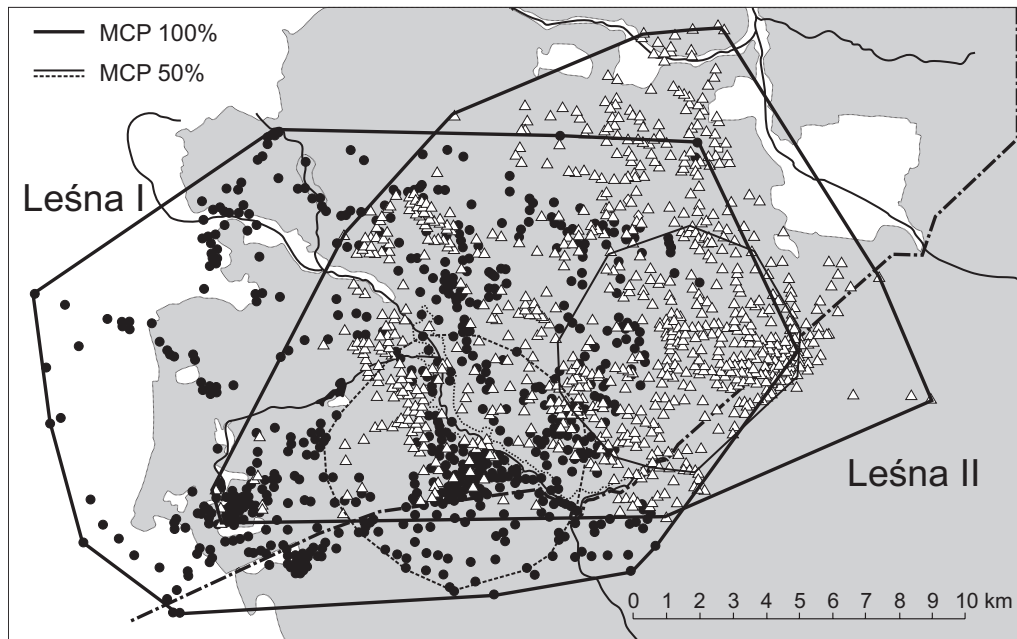


Fig. 2. Home ranges (MCP with 100% of locations) and their core areas (MCP50%) used by the packs Leśna I and Leśna II in March–December 1998. MCP100% ranges based on 2907 and 2956 radio-telemetry locations.

female (Syta) in October. In November–December, the spatial situation of territories of the two packs was apparently unstable. The new Leśna II pack moved its core area westwards into the former range of pack Leśna I (Fig. 1). Syta dispersed from her maternal pack in January 1999, and the radio-collar of Siwa (from pack Leśna II) failed in late December 1998. We were not able to follow the fates of the two packs beyond the winter 1998/1999. Nonetheless, the one-year data show that, in the process of pack splitting, the territories of the new packs were nearly exclusive only during the parturition and early pup rearing (Table 1). After the first breeding season, the ranges used by the new packs again overlapped extensively, though their core areas remained separated (Table 1).

The MCP100% home ranges from March to December 1998 were 277 km² for Leśna I and 217 km² for Leśna II. For Leśna I the MCP95% was 191 km², the MCP75% was 113 km², and the 50% MCP core area was 48 km². For Leśna II, the MCP95% was 172 km², the MCP75% was 119 km², and the 50% MCP core area was 40 km² (Fig. 2). Based on snowtracking in the following winter seasons (1999/2000 to 2001/2002), we continuously recorded two packs of wolves in that region. However, we do not know how they related to the packs Leśna I and Leśna II.

Genetic analyses (microsatellites and mtDNA) showed that Bura, Siwa, Syta and a juvenile female captured in Leśna II territory in 1998 had the same haplotype of mtDNA. The pairwise coefficient of relatedness (calculated by programme

Table 1. Bimonthly changes in the percentage overlap of the ranges used by two wolf packs (Leśna I and II) in the process of their splitting. MCP100% and MCP50% – Minimum Convex Polygons with 100 and 50% of telemetry locations. See Fig. 1 for the positions of ranges. Note that there is no data for July – August 1998.

Bimonthly period	Percentage overlap of territories	
	MCP100%	MCP75%
November–December 1997	99	87
January–February 1998	61	48
March–April 1998	36	0
May–June 1998	11	0
September–October 1998	32	24
November–December 1998	53	5

Cervus) between Bura and the juvenile female (grandmother and granddaughter) was 0.371 (W. Jędrzejewski and co-workers, unpubl. data). Thus, genetic material was consistent with the ecological observations, suggesting that the two packs were formed by female offspring from a single maternal line.

Discussion

In a wolf population recovering from control in Yukon, Canada, four packs increased to a large size (on average, 14 wolves) and then split into a total of 9 smaller groups during 5 years (Hayes and Harestad 2000). Usually, packs split into two parts, but splitting into 3 smaller groups in the same year was also recorded. After 5 years of population recovery, 39% of packs originated from splits and they all established home ranges nearby their original packs (Hayes and Harestad 2000).

In a naturally-regulated wolf population in Denali National Park and Preserve, Alaska, Meier *et al.* (1995) observed two cases of pack splitting during 7 years, in a total of 72 pack-years. Both times in large packs of 15 wolves with a history of multiple litters split. The new groups subdivided the home range of the original pack. In the Denali population, pack budding (formation of a new pair by a dispersing wolf paired with a stranger) was more common. At least 6 budded packs were recorded during the same study period (Meier *et al.* 1995).

In Białowieża Forest, female Bura lost her alpha status in the year preceding the pack splitting. In Denali, in one of the packs split was preceded by the death of an alpha female (Meier *et al.* 1995). In the Isle Royale, splitting of a pack was also circumstantially linked to death of an alpha female (Wolfe and Allen 1973).

The original Leśna pack split when it was 7 wolves, smaller than packs in the northern regions of America. However, by European standards, it was a large pack. In over 100 packs censused in Poland, most had 4–6 wolves, the largest one contained 10 wolves (Jędrzejewski *et al.* 2000b). The largest recorded pack in Białowieża Forest consisted of 11 wolves (Okarma *et al.* 1998). Jędrzejewski *et al.* (2002a) proposed that, in European temperate forests, pack size of 5–6 wolves is

optimal for the consumption of the red deer *Cervus elaphus*, the roe deer *Capreolus capreolus*, and wild boar *Sus scrofa*. These prey are much smaller than moose *Alces alces*, the main prey in the North American studies described above. In Białowieża Forest, radio-tracked packs varied from 2 to 8 wolves (Okarma *et al.* 1998, Jędrzejewski *et al.* 2002a). Packs of 5–6 wolves split temporarily into smaller subgroups for hunting on 41% of known hunts. The Leśna pack (7 wolves) was never observed hunting together. Thus, food related factors could have been the ultimate cause of splitting of a large pack.

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