

Brown bear population structure in core and periphery: analysis of hunting statistics from Russian Karelia and Finland

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Abstract: Russian Karelia is inhabited by a dense, stable brown bear (*Ursus arctos*) population. To the west of this core area, in Finland, bear numbers have increased roughly 5-fold since the late 1960s, but densities are still lower than in Karelia. Because dispersal patterns of males and females are different, the population structure may differ between these two regions. We examined potential differences by comparing the body mass distribution and sex ratio among hunter-killed bears between Russian Karelia (data from 1960–90) and Finland (data from 1978–99), and the possible change in age class and sex ratios in Finland with the distance from Finnish–Russian frontier. Small (<100 kg), obviously young bears are more common in Finland than Karelia, although this result may arise either from true differences in age structure or from different harvest practices in the two countries. The proportion of males and subadults (2–4 years of age) among hunter-killed bears >1 year old increased significantly with the distance from the frontier between Russian Karelia and Finland. Our results are likely explained by male-biased dispersal of subadults into Finland from core areas in Russian Karelia and the frontier zone regions between Russian Karelia and Finland.

Key words: brown bear, core, Finland, Karelia, periphery, population structure, Russia, *Ursus arctos*

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In expanding brown bear populations, population structure in regions recently colonized by bears differs from that in core regions (Pulliainen 1990, Swenson et al. 1998, Kojola and Laitala 2000). Males are more prone to disperse from natal grounds than females (Reynolds 1993, Swenson et al. 1998), whereas in expanding, increasing populations some subadult females may also disperse far from their mother's home range (Swenson et al. 1998, Kojola and Laitala 2000).

Russian Karelia is inhabited by a dense, stable brown bear population (Danilov 1994, Danilov et al. 1998). In Finland, west of this high-density bear population, a major decline in numbers and distribution of brown bear occurred late in the 19th century (Palmen 1913). This restricted the population to the northern and easternmost parts of the country until the 1970s, when the population gradually expanded its range to the west and south. Brown bears in Finland increased from 150 to 750 between the late 1960s and the mid-1990s (Pulliainen 1997) and were still estimated to be increasing in the late 1990s (Kojola 2000). Currently bears also inhabit the

western and southern parts of Finland (Pulliainen 1990, 1997). Cubs were first observed in western Finland in the early 1990s (Jukka Purhonen, Chief of the Game Management District of Central Finland, Jyväskylä, personal communication, 2000).

Kojola and Laitala (2000) found that the proportion of subadults (2–4 years of age) among bears harvested in Finland showed an increasing but not significant trend relative to the distance from the Russian border to the west. Additionally, the proportion of females with cubs observed decreased with distance from the border. Here we evaluate differences in the structure of brown bear populations between Russian Karelia and Finland using body mass distribution and sex ratio of hunter-killed bears. We investigate whether sex ratio and age structure of bears shot in Finland varied with the distance from the border between Finland and Russia using a larger dataset than analyzed by Kojola and Laitala (2000).

Study area and methods

The study area comprised Russian Karelia (≈160,000 km² land area) and southern and central Finland

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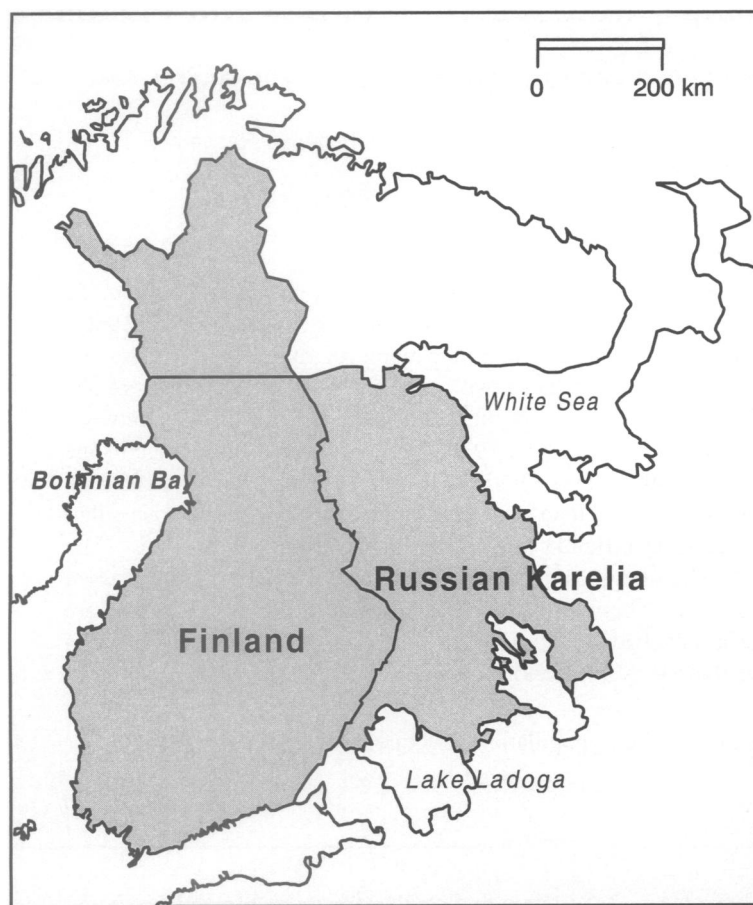


Fig. 1. Location of study area for core population of brown bears in western Russian Karelia and peripheral population in southern and central Finland, 1960–99.

($\approx 220,000 \text{ km}^2$; Fig. 1). Both areas are dominated by boreal forests (Ahti et al. 1968). There were $\approx 2,500$ – $3,000$ bears (Danilov et al. 2000) in Russian Karelia and ≈ 600 – 700 bears (estimated from a mean density of 3 bears/ $1,000 \text{ km}^2$, Kojola 2000) in our study area in Finland. Thus the mean brown bear density in Russian Karelia was about 5–6 times higher than that in Finland. In Finland, densities declined sharply with the distance from the Finnish–Russian border (Kojola and Laitala 2000).

We used data from Danilov (1994) and Danilov and Yakimov (unpublished data) to compare body mass of brown bears shot in Russian Karelia 1960–90) with those in Finland 1978–99. We arranged body mass of bears shot into 7 categories (0–50, 51–100, 101–150, 151–200, 201–250, 251–300, and $>300 \text{ kg}$). Because sex ratio and age distributions may be influenced by hunting practices,

which are different between Russian Karelia and Finland, we examined the change in sex ratio and the proportion of subadults (2–4 years of age, see Swenson et al. 1998) of bears >1 year old shot in Finland 1996–2000 in relation to the distance from the border between Russian Karelia and Finland. We classified distances into 0–10, 11–20, 21–40, 41–80, and $>80 \text{ km}$ from the border. Bears shot in Finland were aged at Matson's Laboratory (Milltown, Montana, USA) based on cementum annuli in rudimentary pre-molar teeth.

Results and discussion

The sex ratio of bears >1 year of age increased with distance from the Russian-Finnish frontier (Cochran's test for linear trend, $\chi^2 = 4.4$, 1 df, one-tailed $P = 0.017$, Table 1). We interpret this result to indicate the effect of male-biased dispersal on population structure in the periphery. The distribution of bears within different categories of body mass differed significantly between Russian Karelia and Finland ($\chi^2 = 33.0$, 6 df, $P < 0.001$, Fig. 2). Forests in Finland are more commercially harvested, but this is unlikely to slow bear body growth because thinned mature forests and clear-cut sites are

productive places for bears foraging on berries, a main source of energy (at least in Scandinavia; Dahle et al. 1998). Furthermore, the densities of the primary prey, moose (*Alces alces*), are much higher in Finland than in Russian Karelia (Linden et al. 2000). Because the sex ratio of harvested bears did not differ ($\chi^2 = 0.4$, 1 df, $P = 0.618$) between Russian Karelia (73.1%, $n = 354$) and Finland (67.6%, $n = 426$), the difference in the distribution of bears into different categories of body mass may indicate differences in age structure. Firm conclusions are premature because data on growth rates are not available from Russian Karelia. Furthermore, hunting practices differ between these areas. Baiting is banned in Finland, whereas most bears in Karelia are shot at oatfields or at baits (Danilov 1994). Baiting sites may attract bears from long distances, enabling hunters to select larger bears.

Table 1. Sex ratio of brown bears >1 yr of age shot in Finland and distance from the Finnish–Russian frontier, 1996–2000.

Distance (km)	Males (%)	n
0–10	55.5	68
11–20	69.7	33
21–40	56.3	32
41–80	66.7	18
>80	80.6	31

The proportion of subadults among bears >1 year old increased with the distance from Finnish–Russian border (Cochran's test for linear trend, $\chi^2 = 6.0$, 1 df, one-tailed $P = 0.007$, Table 2). Together with the increasing proportion of males, this result provided evidence of the influence of male-biased subadult dispersal on the population structure in the more peripheral areas in Finland. Because of a decline in the proportion of females and adults with the distance from Finnish–Russian frontier, only the easternmost part of Finland appears to belong to the core area of Russian–Finnish bear population.

Management implications

Available statistics provide evidence that harvest rate in Finland has been higher than in Russian Karelia. According to hunting statistics, a mean of 85 bears were harvested in Finland yearly during 1996–2000, suggesting an approximately 11% harvest rate from an estimated minimum population of 800 bears (hunting statistics from Ermala, unpublished data). Minimum estimates were based on counts of the litters-of-the-year (Kojola 2000) and the suggestion that females with cubs-of-the-year represent about 10% of the total number of bears (Swenson et al. 1995). Annual harvest in

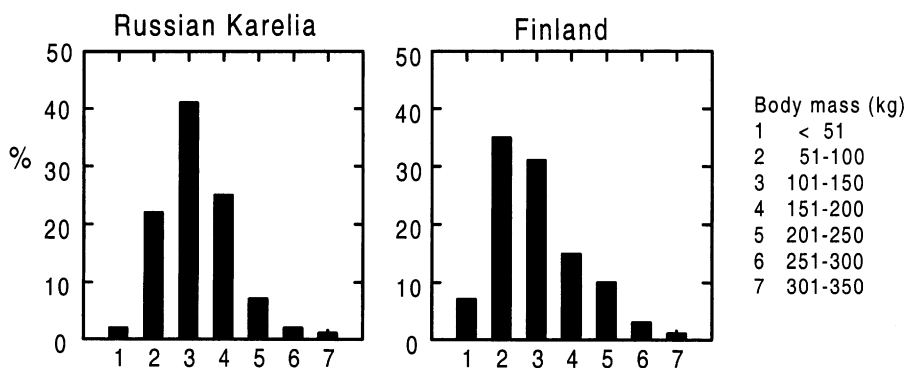
Table 2. The proportion of subadults (2–4 years of age) in brown bears >1 yr old harvested in Finland and distance from Finnish–Russian frontier, 1996–2000.

Distance (km)	Subadults (%)	n
0–10	47.1	68
11–20	48.5	33
21–40	56.3	32
41–80	83.3	18
>80	64.5	31

Russian Karelia has varied between 130–150 bears (Danilov, unpublished data) or about 4–6% of an estimated 2,500–3,000 bears. Because the proportion of subadults, which are most prone to disperse, increased with the distance from Russian Karelia, an increase in hunting pressure in this core region might retard the dispersal rate. This should be considered when determining harvest rates in Finland. An annual harvest of 14–16% has been estimated as sustainable in Scandinavian bear populations (Sæther et al. 1998), but the peripheral nature of the Finnish population implies that even a smaller harvest rate may be too high to maintain the current population size in Finland, especially if hunting pressure in Russian Karelia increases.

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**Fig. 2. Distribution of hunter-killed brown bears within body mass categories in Russian Karelia (1960–90) and Finland (1978–99).**

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