YEARLING MOOSE BODY MASS: IMPORTANCE OF FIRST YEAR'S GROWTH RATE AND SELECTIVE FEEDING

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ABSTRACT: Calf and yearling moose (*Alces alces*) in southeastern Norway are larger on the east side than on the west side of the Oslo fjord. We compare size of calf and yearling moose and general range conditions on the 2 sides of the fjord. We conclude that differences in calf growth rate during the first summer are responsible for the larger animals on the east side. Although forest site quality is better and browse biomass is higher on the west side, selective feeding by lactating cows apparently results in increased milk production and supports a higher growth rate of calves on the east side of the fjord. During their second summer, animals in the 2 areas have similar increases in body mass. It is concluded that autumn body mass of calves gives a better indication of summer range quality than autumn body mass of yearlings. Data from gross browse surveys should be interpreted with care.

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Age-specific body mass is a commonly used criterion for evaluating the nutritive status of deer species (Klein 1970, Reimers *et al.* 1983, Sæther and Haagenrud 1983, Skogland 1983), and is also useful as an "*in vivo* index" of habitat quality (Messier and Crête 1984). Body mass of calf and yearling moose in southern Norway varies up to 10 - 20 kg between regions (Hjeljord and Histøl 1999). Low body mass tended to correlate with extensive feeding on birch (*Betula* spp.), while large body mass correlated positively with the proportion of willow (*Salix* spp.) and forbs in the diet. Composition of the summer diet was a main determinant of size variation between animals from different populations (Hjeljord and Histøl 1999). Here we test this conclusion by analyzing and comparing animal growth rate and range characteristics in a region of particularly large animals and a nearby area where animals are significantly smaller.

METHODS

Particularly large moose are found in the county of Østfold in the southeastern corner of Norway on ranges bordering the Oslo fjord. Considerably smaller moose are found in the county of Vestfold 10 - 20 km to the west, on the opposite side of the Oslo fjord (Fig. 1) (Hjeljord and Histøl 1999).

In Vestfold there are extensive Cambro-Silurian sediments and generally better soil quality compared to Østfold where slowly weatherable Precambrian bedrock dominates. Both areas are within the boreal forest zone. However, Østfold has more forest area dominated by pine (*Pinus sylvestris*) (48 %) than Vestfold (16 %), while there is more area dominated by deciduous trees in Vestfold (29%) than in Østfold (5%). Beech (*Fagus silvaticus*) is common in Vestfold but rare in the study area in Østfold. In Vestfold there are slightly more agricultural fields partly interspersed within the forest compared to Østfold (24% and 21%, respectively) (Nor-

Fig. 1. Location of the study areas, Østfold and Vestfold, in southern Norway.

wegian Institute of Land Inventory 1993). Average mid-winter snow depth is 35 cm in Vestfold compared to 28 cm in Østfold (1961-1990, Førland 1993). In both areas forest is harvested by clearcutting.

We selected one study area in Østfold and one in Vestfold, each about 1,000 ha in size. Occurrence of browse species, tall forbs and feeding signs by moose were recorded by random selection of 11 forest stands of comparable site quality and age in each study area, and systematic plot sampling within each stand. Circular, 4 m^2 and 12.5m^2 plots (n = 667), were located, respectively, in young forest of high browse density and in older forest of lower browse density. Horizontal coverage (%) of forbs and browse species < 3 m in height was estimated. Using the method of Hjeljord and Fjellbakk (1982) we selected a combination of forest stands and sample plots which gave a standard error < 10% on estimated browse coverage. Browsing pressure, including previous summer and winter browsing, was quantified by recording the proportion of plots where the different tree species were hedged by browsing. This includes both dead and dying trees and trees still alive but prevented from height increment by heavy browsing.

Body mass data were collected from calf and yearling moose shot during the hunting season (mainly during the second week of October) and were available in Vestfold for both calves (n = 1,277) and yearlings (n = 742) for the years 1970 - 1994. In Østfold similar data were available for the years 1975 - 1994 and 1981 - 1994 for calves (n = 321) and yearlings (n = 292), respectively. We also estimated average body mass increment of calves from their first to their second autumn by subtracting average body mass of calves in year n from body mass of yearlings in year n + 1. Moose body mass is defined as carcass mass (total body mass minus skin, viscera, lower legs, head, and blood, *cf.* Langvatn 1977). Body mass data were related to population density by using hunting yield as an indication of change in population size. Variations in hunting yield (yearly quotas are set by local game authorities) correlate closely to changes in number of moose seen per hunter per day (Solberg and Sæther 1999). Number of calves per cow (an approximation of the twinning rate) was compared between the 2 study areas from hunter observations between 1986 - 1993. The number of cows observed with calves each year varied between 1,276 and 1,909 in Østfold and between 793 and 1,289 in Vestfold (see Solberg and Sæther (1999) for a discussion of the

Norwegian system of hunter observations). During the period 1970 - 1994, harvest from these moose populations has increased dramatically from 313 to 1,220 animals in Østfold and from 278 to 1,001 animals in Vestfold (Statistics Norway 1971, 1995).

The Mann-Whitney *U*-test and *t*-test were used to compare browse coverage/ plot of each browsed plant species and calf twinning rate, respectively. The effect of animal density on body mass was investigated by comparing differences in trend and slope of regression lines between hunting yield and moose body mass. A *t*-test was used to test for differences between regression coefficients.

RESULTS

Comparing regression lines between hunting yield and body mass (Fig. 2), there was a significant decrease in body mass for both calves and yearlings in Vestfold as the number of moose shot/km² increased ($r^2 = 0.51$, $n = 25$, $P < 0.001$ and $r^2 = 0.34$, $n = 25$, $P = 0.002$, respectively), but there is only a weak tendency of decrease for calves and yearlings in Østfold ($r^2 = 0.08$, $n = 20$, $P = 0.24$ and $r^2 = 0.08$, $n = 14$, $P = 0.34$, respectively). At medium animal density, corresponding to 0.6 animals shot/km², and using a 95% confidence interval for the estimated body mass, calves from Østfold were larger (76.6 ± 1.9 kg) than calves from Vestfold (65.0 ± 1.2 kg) (Fig. 2). There was no difference in body mass increment of calves between the study areas (Østfold: 74.4 ± 4.2, Vestfold: 74.6 ± 2.2). Yearlings in Østfold were larger (150.7 ± 3.0 kg) than yearlings in Vestfold (140.4 ± 2.4 kg).

The number of calves per cow with calves reported by the hunters in autumn was higher ($t = -7.91$, 14 df, $P < 0.001$) in Østfold (1.44 ± 0.017) than in Vestfold (1.24 ± 0.018). This indicates that there were probably more twins among the calves from Østfold than among the calves from Vestfold.

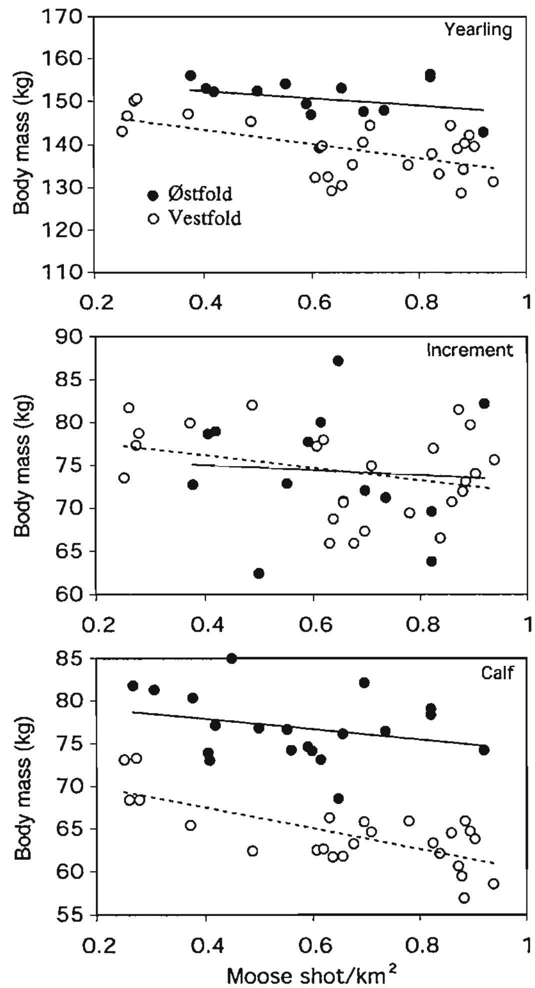

Fig. 2. Relationship between autumn body mass of calf and yearling moose and number of moose shot per square kilometer in Østfold and Vestfold. Also shown is the increase in body mass from year n (calves) to year n+1 (yearlings).

Both coverage of single species and total coverage of deciduous trees are higher in Vestfold ($P < 0.05$, $n = 667$). Total coverage of forbs, of *Pteridium aquilinum* and of *Vaccinium myrtillus* are higher in Vestfold ($P < 0.05$, $n = 667$). For the rest of the forb species coverage is not significantly different between the 2 areas. While the browse layer in Østfold is dominated by birch, several browse species occur regu-

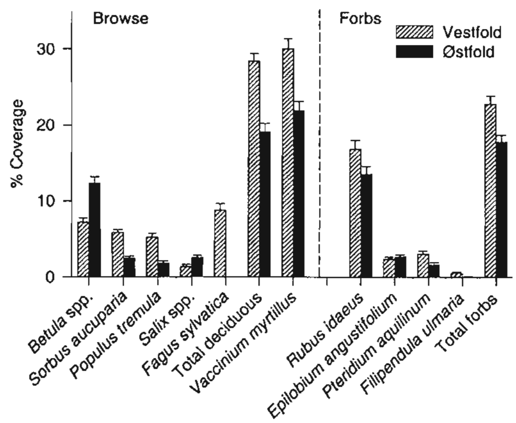

Fig. 3. Average horizontal coverage (%) by important browse and forbs on circular sample plots in Østfold and Vestfold. Bars above columns give standard error (SE).

larly in Vestfold (Fig. 3). There is no significant difference between Østfold and Vestfold in the proportion of plots with heavily browsed individuals for any of the species ($P > 0.05$, $n = 11$) (Fig. 4).

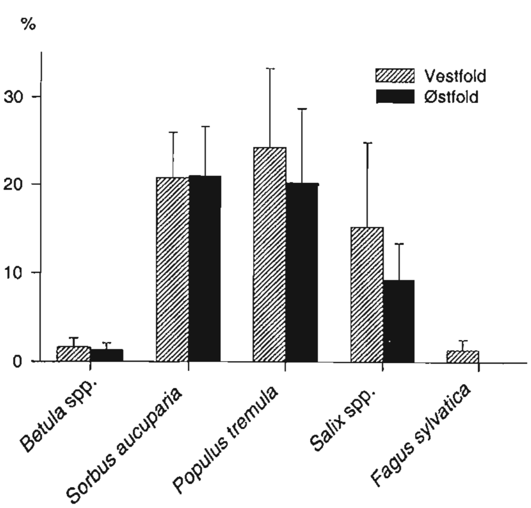

Fig. 4. Percent of circular sample plots where tree species in Østfold and Vestfold were subjected to heavy browsing and hedging by moose. Bars above columns give standard error (SE).

DISCUSSION

Two main conclusions are evident from our analysis of body mass: calves have a higher growth rate during their first summer in Østfold compared to Vestfold, and by the next fall calves from both areas gain about 75 kg. The relatively higher body mass increment of calves in Vestfold could be caused by a lower loss of, or even an increase in body mass during winter, thereby compensating for lower quality of summer forage. However, there is no indication that winter ranges are better in Vestfold, nor that combined browsing pressure, winter and summer, is lighter in Vestfold (Fig. 4). Historically, there have been several reports of heavy browsing on spruce during winter in Vestfold but not in Østfold (Furulund 1977). Spruce is the least preferred winter food of moose (Bergstrøm and Hjeljord 1987), and, if anything, this would indicate lower quality of winter ranges in Vestfold compared to Østfold. Furthermore, during the late 1980's and early 1990's there were several winters with little or no snow, and moose fed largely on the preferred bilberry in both areas (Hjeljord *et al.* 1990, Histøl and Hjeljord 1993). This lesser competition for winter forage caused no change in yearling body mass during the following autumn (Hjeljord and Histøl 1999). Apparently, browse on Scandinavian winter ranges with < 10 % crude protein and low digestible energy (Hjeljord *et al.* 1990) is not of sufficient quality to support body growth. It should be noted that normal snow cover in these areas bordering the fjord is not very extensive and differences in snow cover between the 2 study areas are small; in fact, there tends to be more snow in Vestfold.

The number of cows with twins observed in the autumn in Østfold is close to twice that observed in Vestfold. Because autumn body mass of twins is generally lower than body mass of single calves

(Sæther *et al.* 1992), and individual twin calves are smaller than single calves at birth (Schwartz and Hundertmark 1993), this means that differences in growth rate between calves in the 2 study areas are even greater than indicated by our comparison of autumn body mass data.

The decrease in body mass with increasing hunting yield (slope of regression lines, Fig. 2) is significant only for Vestfold and indicates that quality of forage has decreased at a faster rate with increasing population size and browsing pressure here compared to Østfold. In Vestfold, moose calves on a mixed milk/plant diet during their first summer are clearly at a disadvantage compared to calves on a similar diet on the summer ranges in Østfold. However, during their second summer, on a pure plant diet, moose in Vestfold do as well as moose in Østfold. Suttie and Hamilton (1983) found that small red deer calves from poor winter ranges increased their growth rate relative to larger well fed calves, when the 2 groups were placed on the same summer range. Our data show that this growth compensation takes place even if the small sized calves are confined to forage of lower quality compared to the larger calves during their second summer. This phenomenon is also evident when calves and yearlings from a larger region of southern Norway are compared (Histøl and Hjeljord, *unpubl. data*), and implies that summer habitat causes greater variation in body growth rate of moose during the first compared to the second summer of life.

The forests of Vestfold have better site quality (Norwegian Institute of Land Inventory 1993) and a higher gross quantity of browse and forbs than the Østfold area (Fig. 3). There is no significant difference in browsing pressure between the 2 areas (Fig. 4). Some component of the summer diet that was not detected by our gross browse survey must exist to cause the higher growth rate of moose calves in Østfold. White (1983) demonstrated a pronounced effect of difference in female diet on the growth of reindeer calves. He compared 2 groups of lactating female reindeer with calves, confined to either a willow-sedge or a dwarf birch-sedge vegetation type. On the willow range, milk production was higher and calves grew better compared to the dwarf birch range. On the dwarf birch range, fawns were unable to compensate for lower milk intake by greater intake of forage. Body mass changes of the lactating cows did not differ between the groups.

Previous studies of food choice of radio-collared cows in Østfold have shown that animals spend up to 30% of feeding time during summer browsing on eared willow (*Salix caprea*) (Hjeljord *et al.* 1990). As willow contributes only a small part of available forage biomass in Østfold (Fig. 3), the large share of this species in the diet indicates highly selective feeding. We have no similar studies of choice of summer forage from Vestfold. However, feeding behavior of radio-collared moose about 80 km farther down along the west coast (Damli and Roer 1995), where limited data indicate a decrease in body mass of calves and yearlings very similar to that of Vestfold, show willow to be almost absent in the moose summer diet in this area. The species composition of willow in Vestfold has not been investigated, but we suspect that palatable species are lacking in this area, and that this may be the reason for the low growth rate of calves. Studies of summer forage composition by moose in Vestfold are needed to test this hypothesis.

This study shows that factors other than soil fertility and browse biomass affect moose body mass. The most likely cause of the higher growth rate of calves in Østfold is better milk production of cows that feed selectively on nutritious but sparse forage on the summer range. Small differences in composition of vegetation and selective foraging by moose may cause substantial differences in realized range quality. Data from gross browse surveys should be interpreted with care. When body mass data are used to indicate range quality, summer range is better monitored from autumn body mass of calves than from autumn body mass of yearlings.

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