THE SWEDISH MOOSE POPULATION EXPLOSION, PRECONDITIONS, LIMITING FACTORS AND REGULATION FOR MAXIMUM MEAT PRODUCTION

Martin Wilhelmson and Susanne Sylvén
Department of Animal Breeding and Genetics
Swedish University of Agricultural Sciences
S-750 07 Uppsala, Sweden

ABSTRACT

The recent sudden increase in the number of moose in Sweden is discussed. In 1978, 12 million kg carcass was obtained by killing 94,000 animals. The high fertility rate, the abundant feed supply and the regulated, animal licensed, hunting are considered to be the main factors causing the increase in moose number.

Among the limiting factors, climate in terms of snow cover depth seems to be of some importance. The effect of air temperature and predators seem to be insignificant. The main limiting factors in the near future seem to be the availability of metabolizable energy and the demand for better road safety.

The use of population simulation studies for maximum meat production from a winter stock of constant size is also discussed.

Finally a group of problems in urgent need to be solved is listed.

The Swedish moose population explosion constitutes a good example of the way in which a species of game can exploit marginal feed resources when other limiting factors are negligible.

The 1978 moose harvest yielded 94,000 animals. Reckoning with the officially used carcass weight of 130 kg per average animal, this means a meat or carcass yield of more than 12 million kg, representing 2-3 per cent of the total Swedish meat comsumption. A study of the carcass composition has been made by Hansson and Malmfors (1978). This increase is illustrated in Fig. 1 in the form of annual legal harvest figures for the present century.

PRECONDITIONS FOR THE INCREASE

The main preconditions for any increase in population numbers are a sufficiently high birth rate and a low mortality rate.

The high birth rate is probably a consequence of an abundant food supply which makes overwintering possible and promotes a flushing effect during the subsequent season. Under Swedish conditions of food supply, the individual female fertility is normally high. It is a normal situation for an adult female to have twins at heel (Markgren, 1969, 1974; Stålfelt, Norling et al., 1974). This high fecundity, together with a low harvesting intensity and a low natural mortality rate is indicative of

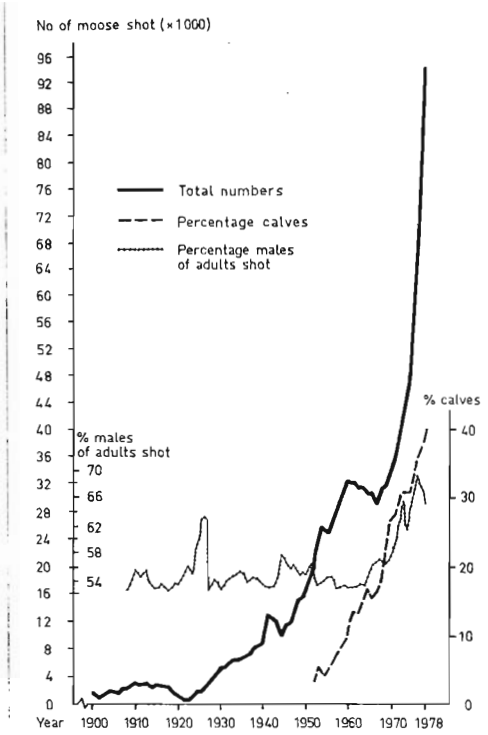

Figure 1. The development of the moose harvest since 1900 (figures from official statistics and from Lykke, 1974)

the population increase which has taken place during recent decades. The abundant feed supply is the result of changing farm and forestry methods, as described by Ahlén (1965, 1971, and 1975). In his 1975 work Ahlén describes the structure of the landscape with its scattered composition of clearcut areas, fields and forests, which gives a lot of wood edges and openings for the production of moose feed.

A retrospective review of the Swedish moose population development and of the present status in Fennoscandia was published by Markgren (1974). Among the causes of the increase, Markgren (1978) recently pointed to the increase in food supply, to a series of mild winters during the past decade and to changes in hunting policy.

The aim of national hunting policy has been to increase the number

of animals in the stock, to raise their average age and thus also to enhance the chance of shooting an animal carrying a good trophy. Harvesting policy has therefore been directed towards the calves, Fig. 1, leaving as a result a population of highly fertile females, difficult to regulate, in the field.

LIMITING FACTORS

Climate

The mean February, July and annual temperatures are tabulated in Table 1 for three places representing southern, central and northern Sweden.

Table 1*. Mean temperatures (°C) for the period 1970-1977 from three localities in Sweden

	Locality and latitude					
	56°02'N Kristianstad		59°50'N Uppsala		67°12'N Pajala	
	$\bar{x}$	$s_{\bar{x}}$	$\bar{x}$	$s_{\bar{x}}$	$\bar{x}$	$s_{\bar{x}}$
Febr.	0.0	0.9	-3.1	1.4	-12.0	1.5
July	17.2	0.4	17.0	0.7	14.7	0.7
Year	7.8	0.2	6.1	0.3	- 0.2	0.7

* The figures are computed from Sveriges meteorologiska och hydrologiska institut, year-book 1970-1977, part 2:2; from monthly and yearly means.

The climate is not one of extreme cold, even in the most northerly

part of the country. In central and southern Sweden where the bulk of the moose stock is to be found, the influence of the Gulf Stream is considerable and the climate rather mild.

According to Gasaway and Coady (1974), it is unlikely that metabolic thermoregulation constitutes any significant energy requirement for moose. Climate as expressed by temperature would thus seem to be insignificant as a limiting factor. On the other hand, climate as expressed by snow precipitation can exert a regulating influence on the stock by reducing the availability of feed and by requiring increased energy expenditure for mobility as indicated in the review made by Coady, 1974. However, the depth of snow cover during normal winters in Sweden has probably only a very marginal effect, if any, on the energy requirements of moose. Fig. 2 depicts the depth of snow cover for February 1976, a fairly normal year as regards snowfall. During the following winter, however, the snowfall was unusually heavy (Figs. 2 and 3). The snow depth averaged around 100 cm over large parts of the country, and moose were reported to have concentrated by lake shores, railroads, roads and some were even sighted in village gardens. Under such conditions, especially when the snow is overlain by an icy crust, feed availability is reduced and climate no doubt exerts a limiting effect on population growth. It must be emphasized, however, that even in 1977 the snow had disappeared from south and central Sweden at the end of April and had diminished considerably in northern Sweden. Thus the period of thick snow cover is relatively short and in great parts of the country less than four months.

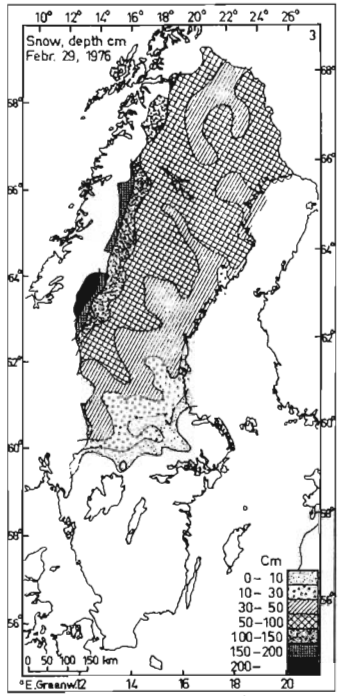

Figure 2. Snow-cover depth in Sweden, February 1976.

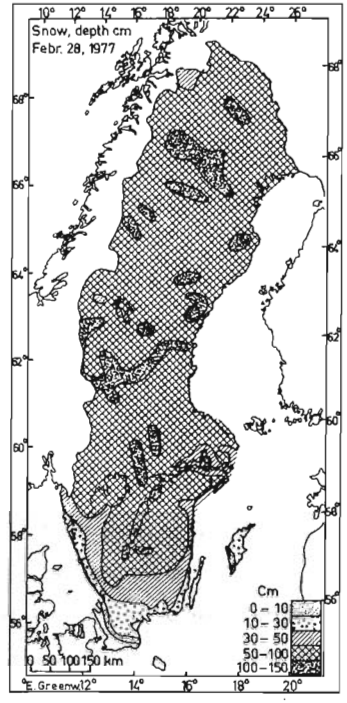

Figure 3. Snow cover-depth in Sweden, February 1977.

Food supply

Changes in land use and new agricultural and forestry methods have resulted in an increased supply of moose food. Ahlén has published (1975) a history of land use. Among the results presented by Ahlén are those of comprehensive analyses of the nutritional quality of most plant species preferred by moose. What are still lacking, however, are *quantitative estimates* of the food supply in terms of *metabolizable*

energy. Some information on this matter can be gleaned from tables of the nutrient contents of various foodstuffs, for example from the work by Breirem and Homb (1970). The values given in such tables, originally worked out for domestic ruminants, run the risk of being estimated from samples not representative with regard to the manner of browsing of the moose. Likewise, the coefficients of digestibility given are estimated from trials on cows or sheep and are not necessarily true for other species. Thus quantitative estimates of the winter supply of metabolizable energy for the Swedish moose population are lacking. It is possible, however, to set a lower limit for this supply. As a main precondition, then, one has to assume that the minimum requirement of energy for maintenance is met by the present supply. This assumption appears to be valid, since our moose stock is probably still increasing.

An average animal in winter stock, including calves, can be assumed to have a live weight of 290 kg (W). This is estimated according to Sylvén *et al.* (1979) and Eriksson *et al.* (1979) and assuming a dressing percentage of 50 per cent. The metabolic weight of such an average animal, including calves not growing during winter, can thus be estimated to $W^{0.73}$ = 63 kg (Blaxter, 1962). This means that an average animal in the winter herd has a maintenance requirement of about $1.36 \times 83.4 \times 290^{0.73}$ = 7.1 Mcal, or 29.8 MJ metabolizable energy per day. The figures are taken from Blaxter (1962) and originally estimated on full-grown cattle. This is obviously a minimum value, since energy will be expended on movement, foraging, and so on.

A rough estimate indicates the size of our winter stock to comprise

about 250,000 animals. This means that, provided the animals do not lose weight, the minimum daily supply of metabolizable energy has to be in the region of 8 million MJ. More exact estimates can only be made when the moose food supply is analysed in terms commonly used in animal husbandry and expressed in units of metabolizable energy.

Energy supply is probably going to be one main limiting factor in the near future, since the requirements must be met by an energy diet of satisfactory quality. This is not the case as regards the protein requirements, thanks to the extremely well developed ability of ruminants and other herbivores to recycle their nitrogen in times of deficiency. In this connection, a review on adaptation to low protein diets has recently been published by von Engelhardt (1978).

Predators

The predatory relationship between moose and our large carnivores was reported on by Haglund (1974). Due to their limited numbers, natural predators do not constitute a limiting factor for the moose population. Man is the only predator of importance, and it is he who bears the responsibility for *regulating* the moose population.

Traffic

Moose constitutes a growing hazard to road traffic (Fig. 4), as illustrated by the increasing numbers of road accidents involving moose during the period 1970-77. Repeated demands have been expressed by the

traffic authorities and other parties concerned, urging the regulation of the moose population. Thus, even if the moose population is not directly regulated by mortality due to traffic accidents, the demand for greater road safety through population regulation will probably also soon constitute one of the main limiting factors.

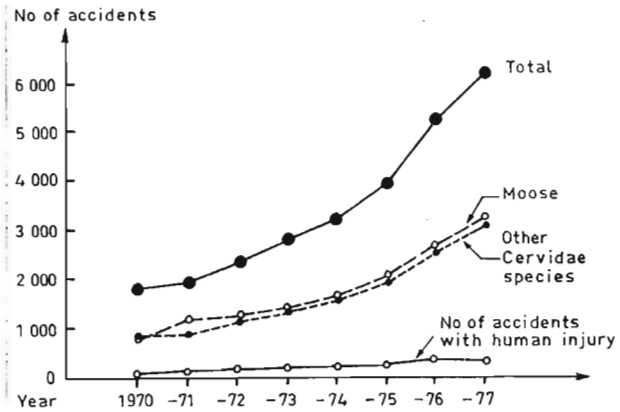

Figure 4. Traffic accidents involving game as reported to the police (according to Statens Vägverk 1978).

REGULATION

Traffic security authorities claim that there are certain localities where there is no room left for further expansion of the local moose population. In the future, we will probably have to harvest from a winter population of about the present size.

It is evident that, by means of hunting, the moose population

should be so regulated in sex- and age-distribution that the maximum production can be extracted from a small winter stock of constant size. The effects of such a policy on population composition and meat production can be evaluated in advance by means of computer simulation. One way of accomplishing this, a computer simulation program for population dynamics studies, has been developed and described by Digernes and Rusten (1977). Their program was adapted to the computer available at our department, its application described by Eriksson *et al.* (1979). In simulation studies on the effects on meat production, the results of varying the population composition are reported by Sylvén *et al.* (1979) and by Eriksson and Sylvén (1979). These results are to be viewed as methodological, for the present, since basic knowledge of parameters of biologically important characteristics of our Swedish moose population are still lacking, to a large extent.

We are of the opinion that the following group of problems needs to be solved in order to furnish possible ways of regulating the moose population in an efficient way. They are given in what we feel to be their order of importance.

(i) development of a field fertility control on a national basis
(ii) estimation of the sex and age distributions in the herds
(iii) evaluation of alternative census methods
(iv) development of methods for population forecasting
(v) quantification of the feed supply in terms of metabolizable energy
(vi) estimation of meat yield and carcass composition in various sex- and age classes and

(vii) ranking of the demands for regulation forwarded by social and economic spheres of interest.

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