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MOOSE AS A PROBLEM IN SWEDISH FORESTRY

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Abstract: Some of the problems arising from the relationship between moose and forestry are presented. Most moose habitats in Sweden are used for commercial forestry. One of the main species of Swedish forestry is Scots pine (*Pinus silvestris*), which also is one of the main food species of the moose during the winter. A high moose utilization of pines will mean losses to forestry. Some investigations on moose damage surveys in pine plantations are presented. Air survey is compared to ground survey. Air survey can be used to evaluate the degree of damage. Moose sometimes break pine stems. The broken trees are mainly between 2 and 4 m, their breast height diameter 15-45 mm.

Moose (*Alces alces*) populations have been steadily increasing in Sweden during the 20th century and especially during the last 15 years. The increase seems to have been especially rapid during the 1970's. During that period the annual kill has increased from about 35 000 to 132 000 in 1980 (Lavsund 1980b, Markgren 1978). In Sweden, all forest land with a potential wood production of more than one cubic metre per year and ha is used for forestry (mainly production of pulpwood and timber). The total forestry area is about 230 000 km^2, i.e., about 50 % of the total area of Sweden. The main habitats of the moose largely coincide with forest land utilized for commercial forestry. To some extent Swedish economy depends on wood production from the forests.

Clear-cut areas and forest plantations are good moose habitats (Ahlén 1975, Krefting 1974, Myrberget 1979, Peek et al. 1976). These man-made habitats may be compared to early successional stages created under natural conditions by fire, wind-throw and insect damage (Lavsund 1980b). Swedish forestry mainly depends on two coniferous species, Norway spruce (*Picea abies*) and Scots pine (*Pinus silvestris*), together making up about 85% of the Swedish wood production. The rest are hardwood species. Spruce is generally very little used by moose. On the other hand, pine in many areas is one of the most essential winter foods (Ahlén 1975, Cederlund et al. 1980). Thus in certain areas a conflict arises between moose food utilization - pine browsing - and forestry. In this paper some aspects of this conflict will be presented.

STUDY AREA

The study area is located at 61°15'N latitude, 15°15'E longitude in Central Sweden. The elevation above sea level is 200-600 m. Snow covers the area from late October until late April. Snow depth at higher elevations reaches 100 cm or more, but in lower areas (with moose winter concentrations) is mainly about 50-80 cm. Dominating vegetation in the area is pine forests of different ages. Commercial forestry covers the whole area and the silvicultural method is clear cutting and plantation or natural regeneration, mainly with pine. There is a migrating moose population in the area leading to heavy concentrations of moose in some parts during the winter. Mean density over an area of 50 km^2 during the period December-March is 7-9 moose/km^2. In other parts of the area, which moose mainly leave during the winter, the density may be only 0.2 moose/km^2 (Sandegren pers.comm.).

METHODS

In 1978 a ground survey of the damage was accomplished (Lavsund 1980a). This survey covered 40-60 % of the total area of pine plantations vulnerable to moose damage. In these areas, damage to pines was evaluated on sample plots covering 20 m² evenly distributed over the area. The degree of damage was described according to the method presented in Appendix 1. The main feature is to describe the degree of browsing and breaking of the tops. In the spring of 1980, while there still was snow on the ground, an air survey was made to test whether aircraft could be used to estimate the degree of serious damage to the pine plantations. The air survey covered all pine stands between 1 and 5 m high which means about 14 km² of young pine divided into about 60 different stands (the individual stands covered an area between 0.02 and 0.81 km²). The air survey was made using a fix winged aircraft (Cessna 182). The survey estimated the percentage of the pines in each stand that were severely damaged by moose (cf. Appendix 1), the number of stems per ha and the mean height of the stand. The last two figures area essential for evaluation of the severity of the damage. To train the aircraft crew (a pilot and an observer) in recognizing from the air the stands with different degrees of damage, three plots covering 0.01 km² each were established with known degrees of damage and which were studied before the survey was started. The aircraft crew already had long experience in estimating the number of stems per area and the mean height of the stand from ordinary forest survey commissions. The air survey of 1980 was made to study the efficiency of the method. Another more extensive survey in April 1981 was made to evaluate the

present damage situation in the area.

The breaking of the tops of pines by moose was studied using 100 m² sample plots evenly distributed over the investigated pine stand.

RESULTS

The ground survey of the damage compared to the 1980 experimental air survey is presented in Figures 1 and 2 and in Table 1. The number of stems per ha and mean height of the stands as estimated by the air survey compared to available ground data are presented in Figures 3 and 4. These figures and the table show that there is a good relationship between the ground figures and the air survey figures. The results of the 1981 air survey are presented in Table 2. In this table the material is divided into two groups - area 1 is from the winter concentration area - area 2 is an area with low moose densities during the winter. The figures give a good indication of the difference in degree of damage between the two areas and the severity of the damage situation in area 1.

A costs analysis of the two surveys shows that the ground survey was much more expensive than the air survey (ground survey $150/km² of pine plantations compared to $100/km² using the aircraft). In 1981, with an experienced aircraft crew (from the 1980 survey), the costs were still lower - about $65/km² of surveyed pine plantations.

The breaking of the tops of pines by moose is sometimes common

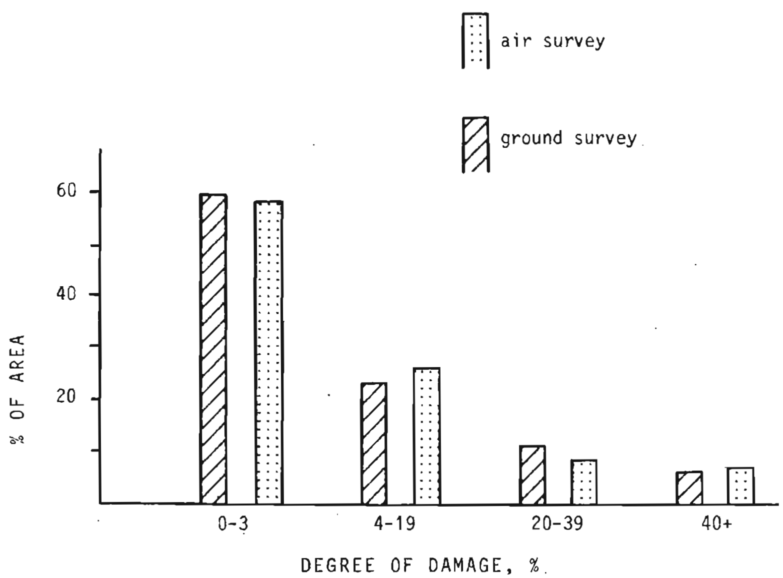

Figure 1. The distribution of the area of pine plantations on different degrees of damage (% of stems with severe damage). Air survey and ground survey.

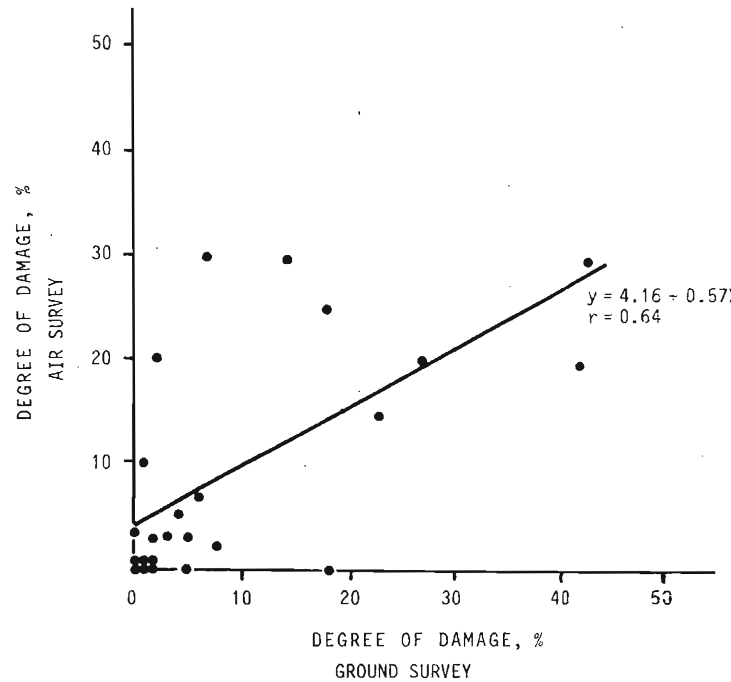

Figure 2. Relation between degree of damage (% of stems with severe damage) according to the air survey and the correspondent degree of damage in the ground survey. The points mark values of single stands.

Table 1. Percentage distribution of the area of pine plantations on different degrees of damage (% of stems with severe damage, cf. Appendix 1). Ground survey and 1980 air survey.

	Degree of damage (% of stems with severe damage)							
	0	1-3	4-9	10-19	20-29	30-39	40-59	60+
Ground survey	34	25	19	7	4	4	7	0
	59		26		8		7	
Air survey	40	20	10	13	6	5	2	4
	60		23		11		6	

Table 2. Percentage distribution of the area of pine plantations on different degrees of severe damage (% of stems with severe damage, cf. Appendix 1). 1981 air survey. Area 1 with dense moose winter population (7-9/km²), area 2 with low moose winter population (1/km²).

	Degree of damage (% of stems with severe damage)						
	0-3	4-9	10-19	20-29	30-39	40-59	60+
Area 1 (16.05 km² pine plantations)	33	14	15	12	4	17	5
		29		16		22	
Area 2 (7.88 km² pine plantations)	38	33	19	8	2	0	0
		52		10		0	

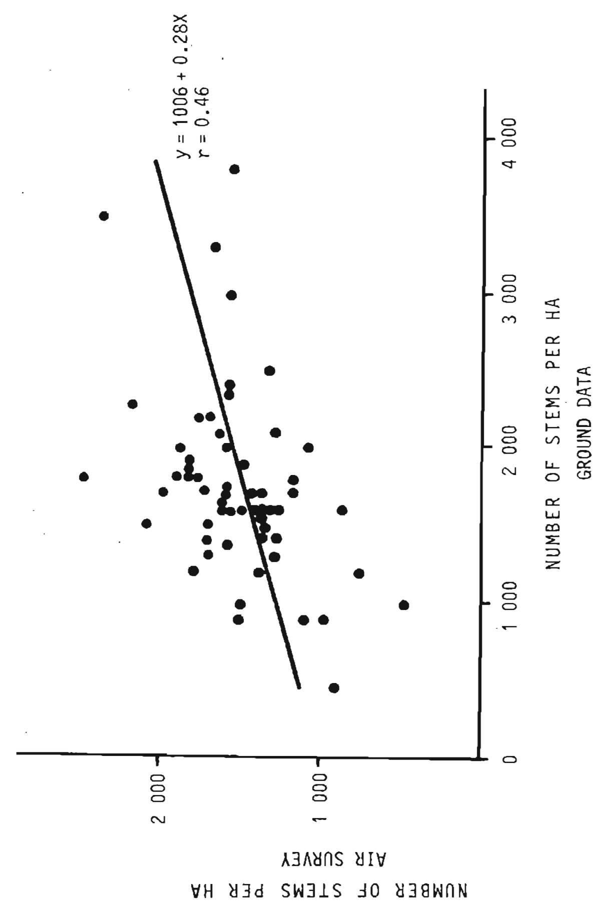

Figure 3. Relation between number of stems per ha in the air survey, and number of stems per ha in the ground data.

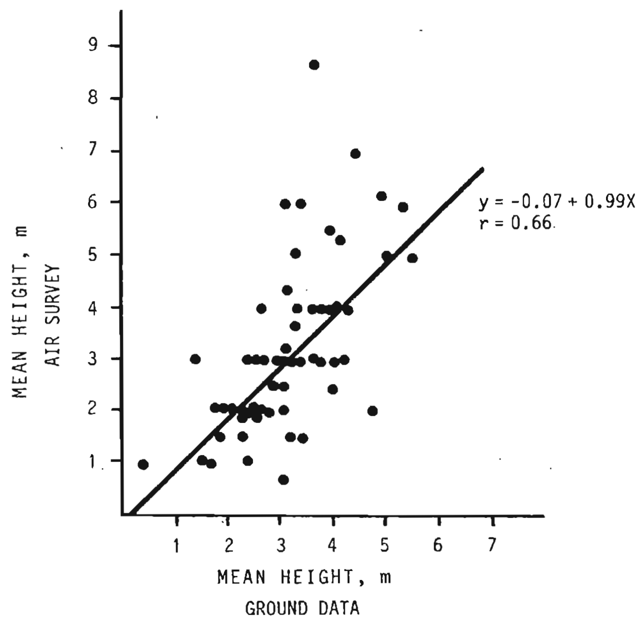

Figure 4. Relation between mean height of the stands as determined by the air survey and available ground data.

when moose utilization of a pine stand is high. This type of damage is severe. Figures 5 and 6 show the diameter and breast height distribution of broken trees. These measurements are especially valuable when determining "the risk period" of a pine stand. The moose will break the trees when they cannot reach the twigs at the top of the tree and when the tree is not too high and/or thick. The trees are broken by means of the moose's mouth, the side of its neck or sometimes by it rearing up, thereby breaking off the tree. When the top is broken the moose usually browse on the twigs in the top. Figures 5 and 6 show that heights up to 3.5-4 meters are in a critical period - breast height diameters are critical up to about 50 mm.

DISCUSSION

In some areas of Sweden moose imply a severe problem to forestry due to their utilization of pine plantations. It is essential from both the forester's viewpoint and that of moose management to evaluate the degree of damage. Ground surveys are time-consuming and expensive. As has been shown in this paper, air surveys can be used to get a clear view of the more severe part of the damage. This type of survey does not give detailed information but, more important, with low labour consumption and fairly low costs per area it is possible to provide a good indication of the actual situation which can be used for management purposes.

The severity of the damage in the investigated area can be evaluated as follows. More than 40 % damage means some kind of a critical

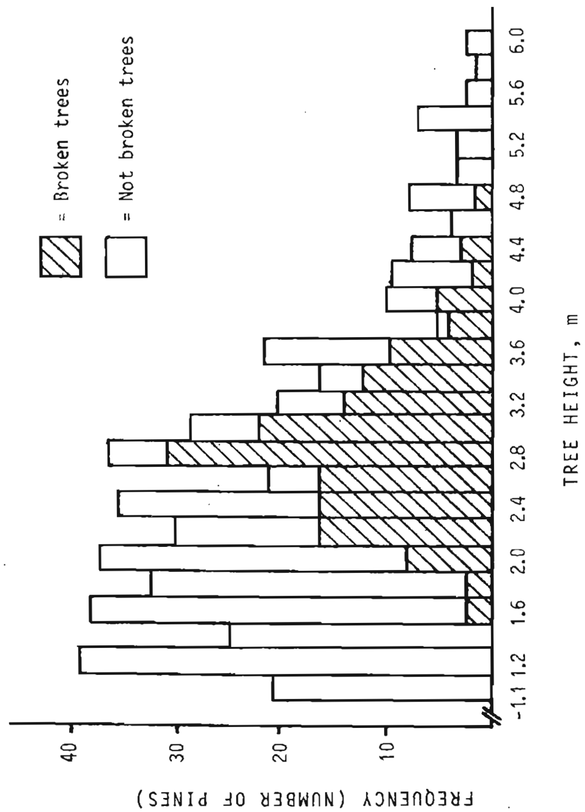

Figure 5. Height of pines broken by moose, and of pines not broken. Total number of pines in a naturally regenerated pine stand, 15-20 years old distributed in tree height classes.

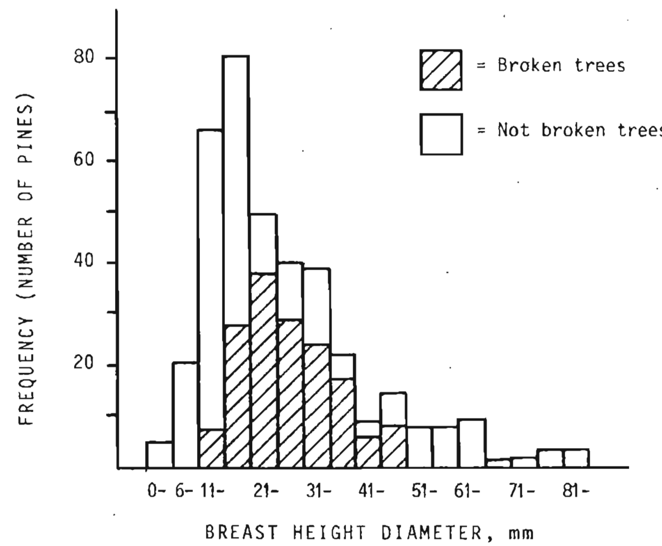

Figure 6. Breast height diameter of trees borken by moose, and of pines not broken. Total number of pines in a naturally regenerated pine stand, 15-20 years old, distributed in breast height diameter classes.

level for the stand - perhaps measures have to be taken to re-establish the plantations. Degrees of damage below 10 % mean some, but not critical, losses to forestry. In addition to the severe type of damage that is covered by the air survey, there will be a certain amount of less severe damage that will lead to some production and quality losses in the future.

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REFERENCES

AHLÉN, I. 1975. Winter habitats of moose and deer in relation to land use in Scandinavia. Viltrevy 9:45-192.

CEDERLUND, G., LJUNGQVIST, H. and MARKGREN, G. 1980. Foods of Moose and Roe-deer at Grimsö in Central Sweden. Results of rumen content analyses. Viltrevy 11:169-247.

KREFTING, L.W. 1974. Moose distribution and habitat selection in north central North America. Naturaliste Can. 101:81-100.

LAVSUND, S. 1980a. Älgens utnyttjande av och påverkan på ungskogs-bestånd i två områden i Värmland och Dalarna. Inst f viltekologi. Mimeo.

LAVSUND, S. 1980b. Relationships between moose and forestry in Sweden with special attention to forest plantations. IUFRO Symposium, Greece, September 1980.

MARKGREN, G. 1978. Älgstammens explosionsartade tillväxt. (Factors behind the recent strong growth of certain Swedish populations of moose (Alces alces).) Fauna och Flora 73(1):1-8.

MYRBERGET, S. 1979. The Norwegian moose population 1945-1977. Meddelelser fra norsk viltforskning, 3 serie, 8:18-33.

PEEK, J.M., ULRICH, D.L. and MACKIE, R.J. 1976. Moose habitat selection and relationships to forest management in northeastern Minnesota. Wildlife Monographs, No. 48.

Appendix 1

Estimation of damage to pines

Damage class 0 = undamaged trees
1 = slightly damaged trees
2 = moderately damaged trees
3 = severely damaged trees

Damage class

0. Undamaged trees

1. Grazing on leading shoots
2. Stem rupture, > 1.5 m left of stem
3. Stem rupture, < 1.5 m left of stem

0. Loss of needle volume, < 10 %
1. Loss of needle volume, 10-50 %
2. Loss of needle volume, 50-90 %
3. Loss of needle volume, > 90 %

1. Bark damage, < 50 % of circumference
2. Bark damage, 50-90 % of circumference
3. Bark damage, > 90 % of circumference

1. Slight upright limb deformity, < 20 mm ø and < 50 cm long
2. Slight upright limb deformity, > 20 mm ø and/or > 50 cm long or repeated

1. Bayonet, slight bayonet deformity, < 20 cm from assumed stem
2. Bayonet, slight bayonet deformity, > 20 cm from assumed stem or repeated

1. Simple forked stem
2. Forked stem, double of multiple

3. Dead trees

A combination of several class 2 types of damage may imply classification in class 3.