Method for Evaluation of Moose Damage in Cultivated Pine Forests of Estonia

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Abstract

In 2006, the Estonian Private Foresters Union made a statement expressing concern about damage caused by moose (*Alces alces*) and roe deer (*Capreolus capreolus*), which hinder reforestation and other silvicultural investments. Forest owners believe that a financial compensation mechanism for the ungulate damages should be implemented. The aim of the study was to create, test and specify a new ungulate damage assessment and evaluation methodology which could be used in compensation procedure. The methodologies from some neighbouring countries were studied to take advantage of their experience. The main differences of a proposed ungulate damage assessment methodology from prior methodologies are a simplified damage classification table and the opportunity to collect information about fresh and old damaged trees and stands. The field study was carried out in 18 pine stands of Aegviidu state forest district. The variability of ungulate damage on the test area ranged from the highest number of 5,200 trees per hectare to the smallest number of 150 trees; there were 150 and 3,150 healthy trees on the same sample plots, respectively. Financial loss depends on the number of damaged trees and the age of the damaged stand. Average loss per hectare was 99 EUR (1,556 EEK) in the case of fresh ungulate damage and 293 EUR (4,584 EEK) per hectare where fresh and old damage were summarized. Damage class classification tables were compared with Latvian, Lithuanian, and Finnish damage classification tables. There was strong correlation between the results (Pearson correlation was higher than 0.9); the strongest one was between Latvian and Estonian damage classification tables, r = 0.99, respectively. The estimated damage according to Finnish and Lithuanian damage classification tables was significantly ($p<0.05$) smaller than those of Estonian and Latvian damage classification tables indicated.

Key words: moose, ungulate damage evaluation, financial value of damage, Estonia

Introduction

According to the Estonian forest policy it is necessary to ensure healthy and qualitative ungulate populations, at the same time trying to avoid extensive damage to silviculture and ensure hunting productivity. Hunting and forestry are strongly linked activities; hunting policy was formulated in accordance with forest policy (RT 1997). From an economic perspective, silviculture and hunting oppose each other: to avoid damage and increase income from forests, it is necessary to keep ungulate populations low; on the other hand, gaining maximum income from hunting, the ungulate population should be numerous; however, that leads to unavoidable damage to stands and decreased income. Theoretically, we should seek optimum aggregate benefits for both sectors.

Ungulates can have both damaging and beneficial impacts on forest, but relevant assessment of these impacts is difficult and depends upon the objectives of the forest owner (Reimoser 2003). The financial impact of damage by ungulates can be remarkable, but the calculation of those costs is still theoretical and the results are matters of discussion. Two decades ago, Löyttyniemi and Lääperi, from Finland, reported that moose damage to forestry can be as high as 40-50 million FIM per year (Härkonen 1998). In Austria, roe deer, chamois (*Rupicapra rupicapra*) and red deer (*Cervus elaphus*) are causing damage of at least 220 million euros per year (Reimoser 2003). Estonian data indicates an annual loss of 50 million EEK (3.2 million euros) in less than 10-year-old pine stands and in 20-60-year-old spruce stands (Aderman 2006, Tõnisson and Roht 2006).

In recent years, ungulate damage has been causing concern for Estonian foresters. In 2006, the Estonian Private Foresters Union stated that damage caused by moose and roe deer is making investments in forest regeneration and other silvicultural activities pointless (Anon. 2006). According to the forest owners, hunting organizations should be responsible and compensate ungulate damage, but the idea is opposed due to the fact that these organisations are currently paying rent to the government for hunting rights in

their hunting districts. Furthermore, it is believed that forest owners need to do more to protect young stands with repellents or other methods. At the same time, private owners rarely report about ungulate damage to County Environmental Agencies.

Although the hunting rental fees are transferred back to the hunting sector, ungulate damage has not been compensated yet. In contrast, the Estonian Government is partially compensating the financial loss caused by grey seal (*Halichoerus grypus*) and ringed seal (*Pusa hispida*) to fishermen, and brown bear (*Ursus arctos*), wolf (*Canis lupus*), lynx (*Lynx lynx*), European mink (*Mustela lutreola*), migrating geese (*Anser sp., Branta sp.*) and crane (*Grus grus*) to farmers (RT 2004).

The aim of the study was to create, test and specify an ungulate damage assessment and evaluation methodology, which is related with the financial compensation. When developing the new methodology, the authors' first aim was to balance objectivity and simplicity. The second objective was to compare Latvian, Lithuanian and Finnish ungulate damage classification methodology with Estonian methodology so as to determine how a simpler classification correlates to the more detailed classification. In the case any compensation mechanism will be implemented, the damages in cultivated stands will be compensated. Therefore, an algorithm which takes into account the costs of cultivation made by forest owner, was suggested to calculate financial value of damage.

Material and methods

Field studies were conducted in April 2006 in Aegviidu state forest district (59°17'N, 25°36'E), in North Estonia, an area rich in dry Scots pine (*Pinus sylvestris*) stands. The current study used the same 18 damaged young pine stands that were studied earlier, in 2003 by Palli (2003), and assessed them according to the new ungulate damage methodology. The area of stands varied, from 0.2 up to 10.2 ha; the average stand size was 2.2 hectares and all 18 studied pine stands together were 38.9 ha. Initial density was 2,500-8,000 sowing plots per hectare; the average was 4,500. The majority of stands were protective forests with some restrictions to forest management.

Lithuanian, Latvian, Finnish and Estonian damage classification tables were compared and their differences and similarities were examined on the 30 sample plots with unit area 100 m^2. These thirty sample plots were chosen randomly from the total 175 sample plots from 18 young pine stands assessed only according to the new methodology. Severity of ungulate damage to the young pine trees was assessed by Lithuanian, Latvian, Finnish and Estonian damage classification tables. Later each damage class was multiplied by its coefficient and finally different damage classes were summarized. The calculated number represents totally or 100% damaged trees on the sample plot.

Existing ungulate damage classification instructions are based on three elements:

i) lateral shoot browsing or breakage;
ii) apical shoot browsing or breakage;
iii) bark stripping.

Finnish damage classification table includes five different damage classes (including a group of undamaged trees), Lithuanian classification table four, Latvian classification table three (Table 1), and Estonian classification table two classes (Table 2). The sample plot-

Table 1. Finnish, Lithuanian and Latvian damage classification instructions for Scots pine (Anon. 2001, Anon. 2002, Anon. 2006, Padaiga et al. 1994)

FINNISH

type of damage	I damage class	II damage class	III damage class	IV damage class
lateral shoot browsing	<75%	>75%	together with other damages	together with other damages
apical shoot browsing or breakage	browsed last season growth	browsed last 2 season growth	browsed last 3 season growth	browsed last 4 season growth
bark stripping	without damage	without damage	<50%	>50%
coefficient	0.15	0.3	0.5	1

LITHUANIAN

type of damage	healthy	slightly damaged	moderately damaged	heavily damaged
lateral shoot browsing	<30%	30-50%	>50%	with other damages
apical shoot browsing or breakage	without damage	without damage	one time browsed apical shoot	more than once browsed apical shoot or broken stem
bark stripping	without damage	wounds up to 1 cm, between wounds cambium must be unharmed	>1/3	1/3-2/3
coefficient	0	0.25	0.5	1

LATVIAN

type of damage	healthy	moderately damaged	heavily damaged
lateral shoot browsing	<50%	>50%	with other damages
apical shoot browsing or breakage	without damage	without damage	top broken or browsed
bark stripping	sparsely damaged by thin scratches	<1/3	>1/3
coefficient	0	0.5	1

Table 2. Estonian ungulates damage classification instructions for Scots pine

type of damage	healthy	old (previous) damage	fresh (recent) damage
lateral shoot browsing	<75%	>75%	>75%
apical shoot browsing or breakage	without damage	browsed apical shoot or broken stem	browsed apical shoot or broken stem
bark stripping	<30%	>30%	>30%
coefficient	0	1	1

positioning scheme originating from the Sustainable Forest Monitoring Info System Methodology (Anon. 2007) was used in new ungulate damage evaluation methodology. According to this systematic "zig-zag" transect method (Figure 1), sample plots were randomly set on the damaged area.

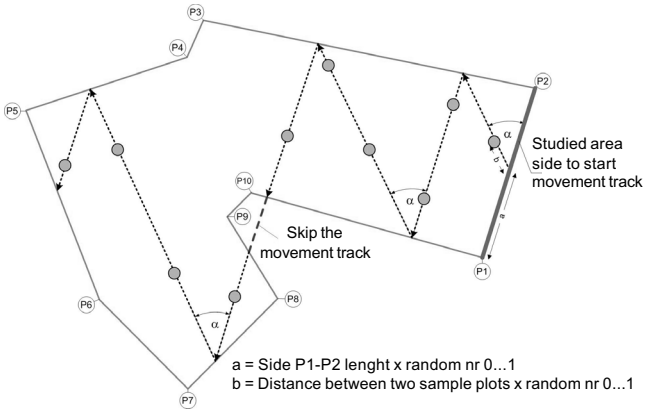

Figure 1. Sample plot positioning scheme on the damaged area

Ungulate damage was registered on the sample plots. Prevailing trees were divided into healthy or damaged ones (Table 2). A tree is damaged when one of the damage class criteria is fulfilled, fresh (less than one year old) and old damage was indicated separately. It is important to cite the time of damage, because if there is significant fresh damage, then the reduction of moose or roe deer population must be considered. In case the tree had both old and fresh damages, the tree was included to the fresh damaged class.

The MS Excel t-Test: Paired Two Sample for Means and Correlation procedure were used to perform the statistical analysis concerning the results of damage assessment by different methodologies.

The prevailing opinion in Estonia is that financial compensations might be implemented first of all in the cultivated stands (plantations), therefore the price of one seedling and planting were chosen. In order to calculate the financial value of the damage, the number of damaged trees in the stand is multiplied by the sum of unit price and cost of planting of one seedling, and then compounded according to the age of the damaged stand (Formula 1). If the methodology is used for compensating the damage, then seedling unit price and interest rate must be agreed upon between concerned parties. In Estonia, the cost data are published by the Centre of Forest Protection and Silviculture in forestry yearbooks. In this study, the sum of pine seedling price and planting cost was 0.13 EUR (2 EEK) and the interest rate 4%.

$$FVD=[NDT*(UP+PC)]*(1+i)^{A}, \quad (1)$$

where:

FVD – financial value of damage to be compensated (EUR);

NDT - number of damaged trees in stand (pieces);

UP - unit price of seedling (EUR);

PC – planting cost of one seedling (EUR);

i - interest rate;

A - stand age.

Results

Variability of ungulate damage in studied stands in the Aegviidu forest district was very high; stands exhibited both heavy and very light damage. Ungulate damage ranged from the highest, 5,200 to very few, 150 damaged trees per hectare; there were 150 and 3,150 healthy trees respectively in the same stands. The smallest initial density of stands before damage was 1,781 and the largest, 5,350 trees per hectare. The cost of the damage depends directly on the number of damaged stems, but also on the age and area of the damaged stands, consequently financial loss values are widely different. The average financial loss per hectare was 99 EUR (1,556 EEK) in the case of fresh ungulate damage and 293 EUR (4,584 EEK) per hectare in the case of summarized fresh and old damage (Figure 2). Comparing Finnish, Latvian, Lithuanian and Estonian damage classification methodologies, the correlation between results of different classification tables was very strong (Pearson correlation > 0.95). The strongest correlation was between Latvian and Estonian damage classification tables ($r = 0.99$) (Figure 3). Despite the positive correlation, the Finnish (143.45 totally damaged trees per 30 sample plots) and Lithuanian (148.25) results were statistically ($p<0.001$) smaller than those of the Estonian (178) and Latvian (179.5) methods. If the ungulate damage assessed by the Latvian damage classification table were estimated at 100%, then the outcome according to the Finnish classification table would be 80%. Using classification tables with more damage classes (Finnish and Lithuanian), show smaller damage estimates than tables with fewer classes (Latvian and Estonian).

Discussion

The ungulate population has reached new levels in many European countries. In the final quarter of the last century, the moose population was highest in Finland, Sweden, Norway, Poland, Latvia, Lithuania and Estonia (Cederlund and Markgren 1987, Nygren 1987, Østgård 1987, Bobek and Morow 1987, Baleishis et al. 1998, Tõnisson and Randveer 2003). In Estonia, moose

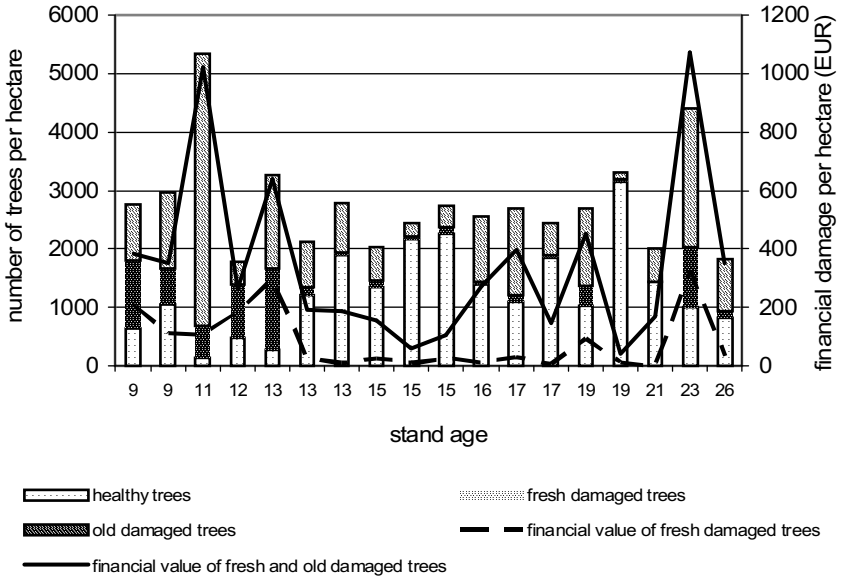

Figure 2. Numbers of healthy, recently (fresh) and previouisly (old) damaged trees and the financial value of fresh and total damage per hectare

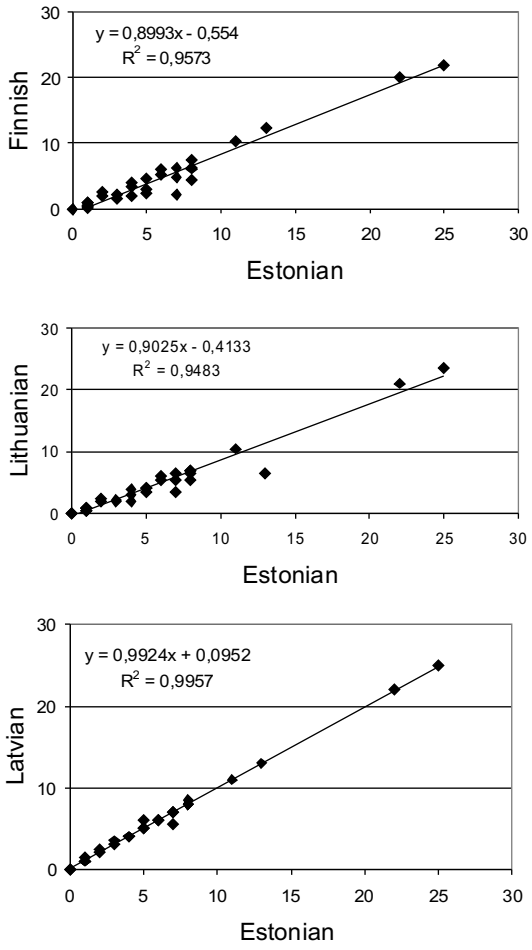

Figure 3. Correlation between the results of a) Estonian and Finnish, b) Estonian and Lithuanian and c) Estonian and Latvian ungulate damage classification tables

was overabundant in 1970-1980s, reaching 20,000 individuals and causing serious damage to young stands (Randveer and Tõnisson 2003). According to the Estonian Environmental Strategy (RT 2005), the maximum number of moose would be 12,000. Recent data (Tõnisson and Roht 2006) indicate that in the winter of 2004 there were 11,700 individuals.

A moose population optimization model developed in Norway indicates that silviculture contributes 94.5-98.5% of forest incomes (Wam et al. 2005). In comparison, income from moose hunting is very low. Therefore, ungulate populations should be managed so that damage would be acceptable and would not reduce the profitability of silviculture.

Studied methodologies of ungulate damage assessment include two concepts in calculating financial loss. The first approach (Finnish and Lithuanian methodologies) is to identify the percentage of damaged trees from the total number of trees; the second one (Estonian methodology) summarizes only heavily damaged trees. All these approaches have strengths and weaknesses. In the Finnish and Lithuanian concept, the amount of damage is depending on the total number of young trees growing in the studied area before the damage. For example, it is possible that in two cultivated sites, both having 1,000 young trees damaged, the total number of trees in the first site is 2,000 and in the second site, 4,000; from the silvicultural perspective the resulting damage in the first is 50% and 25% in the second site, respectively. However, from the landowner's point of view both damages are equal. If the basis for financial loss calculation is the number of totally damaged trees, both owners have the same loss: 1,000 damaged trees.

A potential weakness in the Estonian financial loss formula is that it overestimates the value of damage in a young, naturally regenerated stand. For instance, there could be thousands of trees per hectare and thousands of them could be damaged. According to the calculation, remarkable decrease in the stand value and a high financial loss are indicated. In spite of excessive damage, the number of healthy trees may be sufficient enough to form a good quality stand. One way to avoid the misleading interpretations is to use normatives. For instance, if there are more than 5,000 healthy trees in a pine stand, or more than 3,000 healthy stems per hectare in a spruce stand, the stand should be considered healthy and no compensation should be paid. Therefore, it is suggested that the algorithm for calculation of compensation would be applied only for cultivated young plantations at age up to 10 years.

One possible scenario in young pine stands is repeated browsing. In this case both fresh and old damaged trees should be accounted during the first estimation of damage and calculation of economical loss. Repeated browsing and damage estimations of economical loss are carried out only on these trees which were healthy last time. This mechanism is necessary to avoid compensation of the same tree more than once.

The study showed that the average financial loss per hectare was 99 EUR (1,556 EEK) in the case of fresh ungulate damage and 293 EUR (4,584 EEK) per hectare for summarized fresh and old damage in Aegviidu forest district.

The Estonian financial loss calculation formula might not work properly for all ages of young stands. If the cost of the seedling and planting is 0.64 EUR (10 EEK) and interest rate 4%, then according to the financial loss calculation formula the value of 10-year-old tree is 1.02 EUR (16 EEK) and the value of a 20-year-old tree 1.69 EUR (26.5 EEK). How can one compare compounded and real prices? It is difficult to estimate the real value of a young stand. Real estate market transactions might assign value to a young stand, but no one is selling or buying single stands. Young stand value can also be estimated by analyzing expenses incurred by forest owners.

In Finland, the last decade's average costs of planting are used when calculating the damage value, in Lithuania, the calculated costs of planting are used. Lithuanian methodology also takes into account the economic loss due to the diminishing of increment. Both methodologies are based on the "normal" value of the specific stand. Similar approach would be beneficial also in Estonia when assessing damages in stands with merchantable wood.

Concluding remarks

The financial value of the ungulate damage partly depends on the methodology and damage classification table used for evaluation. The authors developed an ungulate damage assessment methodology, which is rather simple to be used in practice. Its main differences compared to other methodologies are simplified classification table and different base of calculating economical loss. Also, there is an opportunity to collect information about fresh and old damaged trees and stands.

Comparing Finnish, Latvian, Lithuanian and Estonian damage classification tables, the correlation between results of different classification tables was very strong (Pearson correlation > 0.95). The classification tables with more damage classes show smaller damage estimates than tables with fewer classes. The calculation algorithm which includes costs of cultivation and interest rate is valid only for the cultivated young stands to evaluate the loss for forest owner. Authors do not suggest using the approach and the algorithm in naturally regenerated stands. For the evaluation of damage value in older stands the standard stand values or the programs of the calculation should be developed. This would be a future challenge for Estonian forest researchers.

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References

Aderman, V. 2006. Eesti metsad 2005, metsavarude hinnang statistilisel valikmeetodil (Estonian forests 2005: assessment of forest resources by selective statistical method). Metsakaitse- ja Metsauuenduskeskus, Tartu.

Anon. 2001. Hirvieläinvahinkojen arviointi ja korvauksen laskenta (moose damage evaluation and compensation methodology). - *http://www.finlex.fi/data/normit/6329-01029fil3.pdf 10.05.2007* (in Finnish)

Anon. 2002. Medžiojamųjų gyvūnų padarytos žalos žemės ūkio pasėliams ir miškui apskaičiavimo metodika (Methodology for evaluating damages to the agriculture and forestry by game). *Valstybės Žinios* 2002.10.09, Nr.: 97, Publ. Nr.: 4303 (in Lithuanian)

Anon. 2006. Noteikumi par metodiku, kādā nosaka materiālo zaudējumu apjomu, kurus lauksaimniecībai un mežsaimniecībai nodarījuši medījamie dzīvnieki (Methodology to determine game damages to the agriculture and forestry). *Latvijas Vēstnesis* 28. 04. 2006, 68, (3436) regulation nr.334. (in Latvian)

Anon. 2006. Tulevikumetsa hävitavad ulukid! (Ungulates are destroying the future forest). *Maaleht*: *Metsaleht* 6(77), 29.06.2006 (in Estonian).

Anon. 2007. Säästva metsanduse seire infosüsteemi metoodika. (Sustainable forest monitoring info system methodology). Metsakaitse- ja Metsauuendusekeskus. http://meelismerenakk.googlepages.com/smsis (in Estonian).

Baleishis, R., Bluzma, P., Ornicans, A. and Tõnisson, J., 1998. The history of moose in in the Baltic countries. *Alces* 34: 339-345.

Bobek, B. and Morow, K. 1987. Present status of the moose (*Alces alces*) in Poland. *Swedish Wildlife Research Supplement* 1(1): 69-70.

Cederlund, G. and Markgren, G. 1987. The development of the Swedish moose population, 1970-1983. *Swedish Wildlife Research Supplement* 1(1): 55-61.

Härkonen, S. 1998. Effects of silviculture cleaning in mixed pine-deciduous stands on moose damage to Scots pine (*Pinus sylvestris*). *Scandinavian Journal of Forest Research* 13: 429-436.

Nygren, T. 1987. The history of moose in Finland. *Swedish Wildlife Research Supplement* 1(1): 49-54.

Østgård, J. 1987. Status of moose in Norway in the 1970's and early 1980's. *Swedish Wildlife Research Supplement* 1(1): 63-68.

Padaiga, V., Mizaras, S. and Vasiliauskas, R. 1994. Elninių žvėrių padarytų miškų ūkiui nuostolių įvertinimo metodika (Methodology of evaluation of damage caused by deer to forestry). Kaunas-Girionys, 14 p (in Lithuanian).

Palli, T. 2003. Hirvlaste poolt kultuuridele ja noorendikele põhjustatud kahjustuste majandusliku kahju hindamise metoodikate võrdlus (Comparison of methods for economic assessment of damage caused by Cervidae to plantations and young stands). Bachelor thesis. Estonian Agricultural University, Tartu (in Estonian).

Randveer, T. and Tõnisson, J. 2003. Põdra ja metsa suhete ajaloost ja hetkeseisust Eestis. (Moose and forest – relations through the times). *Metsanduslikud uurimused* 38: 115-124. (in Estonian)

Reimoser, F. 2003. Steering the impacts of ungulates on temperate forests. *Journal for Nature Conservation* 10(4): 243-252.

RT 1997. Eesti metsapoliitika heakskiitmine. (Estonian Forest Policy). Riigi Teataja I, 1997, 47, 768 (in Estonian).

RT 2004. Looduskaitseseadus (Nature conservation law). Riigi Teataja I, 2004, 38, 258 (in Estonian).

RT 2005. Eesti keskkonnastrateegia aastani 2010 (Estonian Environment Strategy until 2010). Riigi Teataja I, 2005, 58, 462 (in Estonian).

Tõnisson, J., and Randveer, T. 2003 Monitoring of moose-forest interactions in Estonia as a tool for game management decisions. *Alces* 39: 255-261.

Tõnisson, J. and Roht, K. 2006. Jahindus (Hunting). Aastaraamat Mets 2005 (Yearbook Forest 2005). Tartu, p. 100-112 (in Estonian).

Wam, H.K., Hofstad, O., Naevdal, E. and Sankhayan, P. 2005 A bio-economic model for optimal harvest of timber and moose. *Forest Ecology and Management* 206 (1-3): 207-219.

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МЕТОД И ОЦЕНКИ ЛОСИНЫХ ПОВРЕЖДЕНИЙ В СОСНОВЫХ ЛЕСАХ ЭСТОНИИ

Т. Вахтер и П. Каймре

Резюме

Целью данного исследования стало определение и тестирование новой методики по измерению и оценке ущерба от парнокопытных. Применённая методика по измерению ущерба для определения коррелирующих результатов была сравнена с таблицами классификации повреждений Латвии, Литвы и Финляндии.

30 пробных участков площадью 100 м^2 были измерены согласно новой методике для сравнения с имеющимися таблицами классификации. Была обнаружена сильная корреляция между результатами (r>0.9); самая сильная была между показателями таблиц классификации повреждений Латвии и Эстонии (r = 0.99).

Финансовые потери зависели от количества повреждённых деревьев и возраста повреждённого древостоя. В среднем потери на гектар составили 1 556 эстонских крон (99 евро) в случае свежих повреждений парнокопытных и 4 584 эстонских крон (293 евро) на гектар в случае суммирования свежих и старых повреждений.

Преимущества предложенной методики по измерению и оценке ущерба от парнокопытных включают в себя: 1) упрощённую классификацию повреждений и 2) возможность сбора информации о свежих и старых повреждённых деревьях и древостоях, все перечисленное предназначено для обоснования решений по вопросам контроля поголовья лесных зверей.

Ключевые слова: лось, оценка повреждений от парнокопытных, стоимость повреждений, Эстония