Results from the Swedish University of Agricultural Sciences Nr 4 2017

SLU

# FOREST FACTS

Photo: Mikael Angelstam

# Towards integrated management of wildlife, landscape and people

**Per Angelstam, Simen Pedersen, Michael Manton, and Marine Elbakidze**

**The impact of moose** to economically (Scots pine) and ecologically (aspen, rowan, sallow, and oak) important tree species, and how to manage this, is a hot topic in Fennoscandia.

**To investigate if the study design affects conclusions about the impact of moose browsing damage on young trees we used three designs**: (1) a comparison of managed Swedish forest landscapes, (2) a natural experiment approach in Sweden, and (3) a macroecological approach involving six countries in northern Europe from Norway to Russia.

**Sweden had high moose densities across all landscapes studied**, high overall rates of browsing damage, and therefore a weak relationship between moose density and browsing damage.

Adding a comparison to urban forest areas, which are less accessible to moose, showed **a clear effect of moose density on tree damage** of both deciduous trees and Scots pine. This provides opportunity for restoring decidous forest as a green infrastructure in urban landscapes.

Finally, across 10 landscapes in Sweden, Norway, Finland, Latvia, Belarus and Russia **we found a strong effect of moose on damage** to both economically and ecologically valuable tree species.

We conclude that **research design affects the conclusions about the role of moose density** on browsing damage on economically and ecologically valuable tree species. Management of moose, their predators including man, and forestry and biodiversity conservation, needs be integrated.

Sustainable forest management policy aims at economic, ecological and social sustainability. Implementing this is not straightforward because actors focus on different kinds of benefits, and often have different perspectives, knowledge and power. Seemingly simple matters may actually turn out be complex with many interacting factors.

Loss of large carnivores, such as of wolf and brown bear, leads to increased population densities of large herbivores, such as moose. This may lead to subsequent cascading effects on the composition, structure and function of ecosystems (Figure 1). However, the spatial extent of trophic interactions between large carnivores and herbivores, as well as economically important species, such as Scots pine, and ecologically important species, such as aspen, is very large. This makes it tricky to study because there is a risk that the research design used to study the effects of moose on tree species affects the conclusions. To find out about this, we used the same approach in three research designs to measure moose damage to the economically valueable of Scots pine and the ecologically valueable deciduous trees.

**Managed forest landscapes in Sweden**
First, we sampled 120 young forest stands in the distinct Swedish temperate-boreal forest gradient in Mälardalen and Bergslagen in south-central Sweden. We measured the potential for saplings of aspen, as well as rowan, sallow and oak, to become recruited into the population of ecologically mature trees, and for Scots pine to deliver undamaged logs. Sampling was made in forest stands representing managed forest landscapes accessible to large herbivores. The relationship between large herbivore abundance (> 89 % were moose) and tree damage was weak.

**”...we encourage researchers to carry out macroecological comparative studies that include variation in both landscape history, and different governance and management regimes.”**

**Forests with different access to moose**
Next, we applied a natural experiment approach by comparing the results from sampling in young forest stands in managed forests accessible to moose, and in settlements avoided by large herbivores as a control. Using the same sampling methodology we found that both aspen and other deciduous tree species, and Scots pine, had lower damage levels in towns and villages compared to forest sites.

**Ten study areas in six countries**
Finally, again using the same methodology, we employed a macroecological approach based on studies in 100 forest stands in 10 boreal forest landscapes in the Baltic Sea region and Russia (Figure 2). This gradient ranged from extinct to extant populations of both large carnivores and large herbivores, and high to low forest management intensity. There was an inverse relationship between the numbers of large carnivores and large herbivores. This coincided with a steep gradient in browsing damage on the ecologically important aspen as hosts for specialised species, as well as the economically important Scots pine. In one landscape, hunting had replaced the predation from carnivores. Mean damage levels of all tree species were correlated with large herbivore abundance (Figure 2), but not with forest management intensity.

**Research design matters**
It is important but challenging to understand and manage trophic interactions between predators, prey, and vegetation, and the associated cascading effects in forest landscapes. Disruption of trophic interactions at various spatial scales affects the portfolio of ecosystem services benefitting human well-being, as well as green infrastructure as habitats for species. Policy and management decisions impact trophic interactions, which lead to a mixture of conflicts induced by human–human, human–wildlife and wildlife–wildlife interactions.

Our studies show that the design of research about the impact of large herbi-

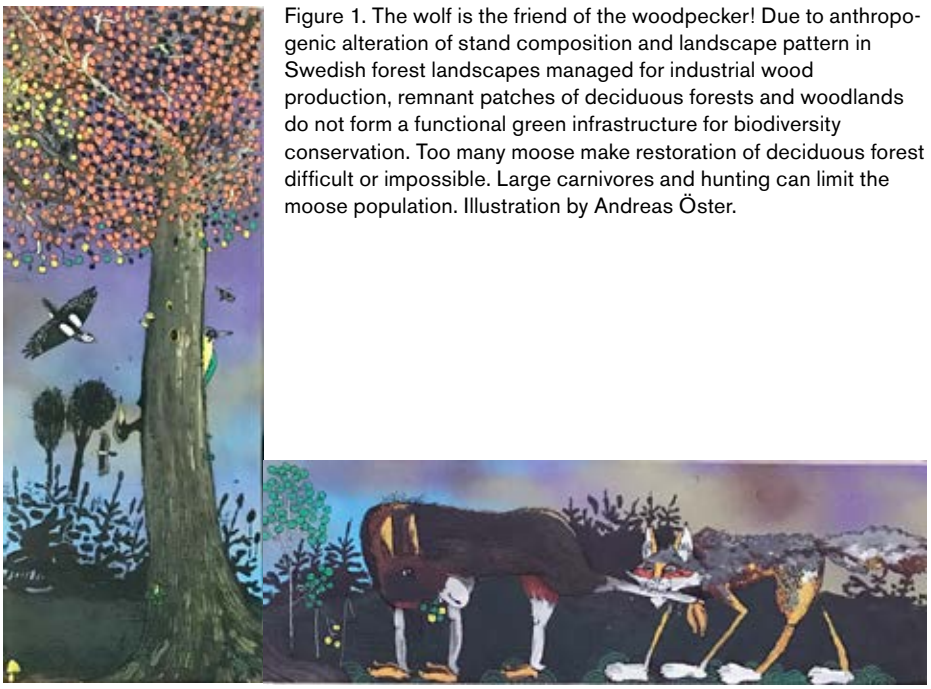

Figure 1. The wolf is the friend of the woodpecker! Due to anthropogenic alteration of stand composition and landscape pattern in Swedish forest landscapes managed for industrial wood production, remnant patches of deciduous forests and woodlands do not form a functional green infrastructure for biodiversity conservation. Too many moose make restoration of deciduous forest difficult or impossible. Large carnivores and hunting can limit the moose population. Illustration by Andreas Öster.

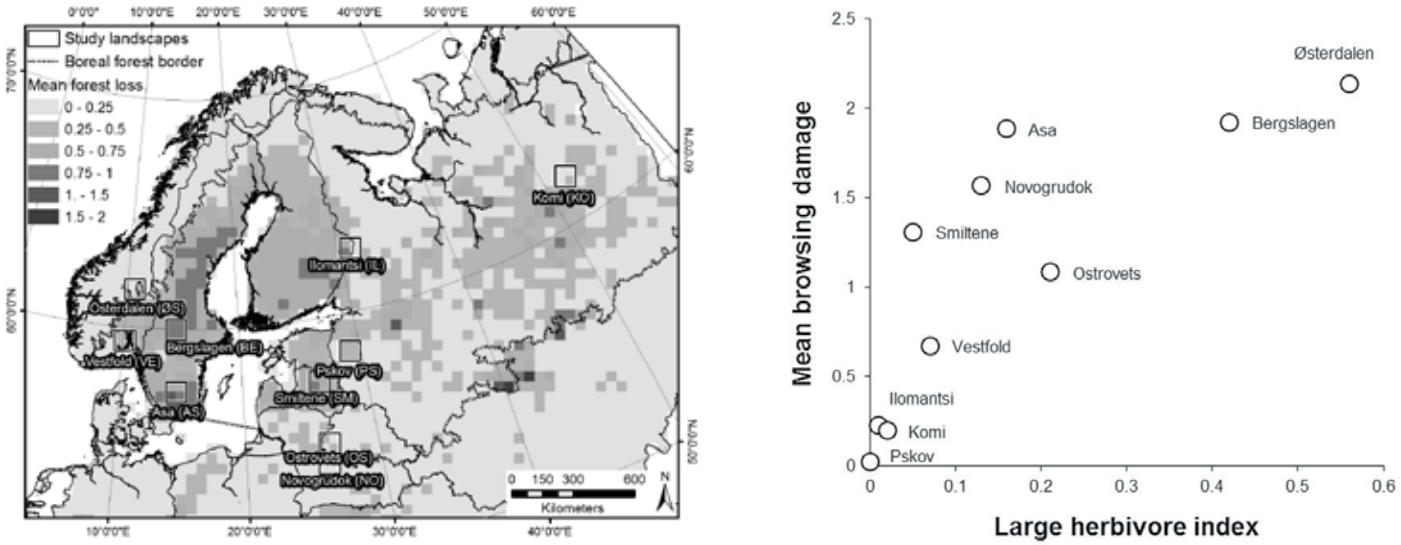


Figure 2. A long history of human-induced factors made large carnivore species go extinct in the south-western part of our study area ranging from Norway and Sweden to Finland, Latvia, Belarus and Russia. The abundance of large herbivores shows the opposite pattern, and is clearly related to the level of browsing damage on both Scots pine and deciduous trees. Adding results from the eight landscapes studied by Angelstam et al. 2000 yields a sample size of 18 and a correlation coefficient of 0.74, and 0.90 if excluding the data from the hemiboreal region (n=14). There was no relationship between moose damage and forest management intensity.

vores on ecologically and economically important tree species affects the conclusions about the role of large herbivores (Figure 3). Depending on what aspect of our research one quotes it is possible to draw very different conclusion about the role of moose for browsing damage on young trees. We conclude that comparative studies that encompass the full range of variability in moose density in northern Europe can enlighten the debate on how to cope with moose damage on ecologically and ecologically important tree species.

**Restore green infrastructure in urban contexts!**

That browsing damages were much lower near towns and villages than in surrounding managed forest landscapes (Figure 4) offers opportunity for restoration of deciduous forests as green infrastructure. This means that spatial planning is necessary, and therefore that collaboration between counties, municipalities and forest planners must be encouraged.

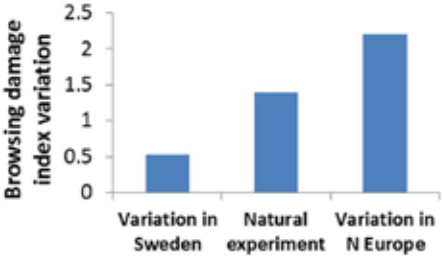


Figure 3. The browsing damage index used in our studies ranged from 0 (not browsed), over 1 (< 50 % of long shoots damaged) and 2 (> 50 % of all long shoots damaged) to 3 (all long shoots damaged) and 4 (all long shoots dead). Comparing different forest stands in south-central Sweden yielded a variation in browsing damage which is only 24 % of the variation observed in northern Europe from Norway to Russia. The natural experiment approach is intermediate.

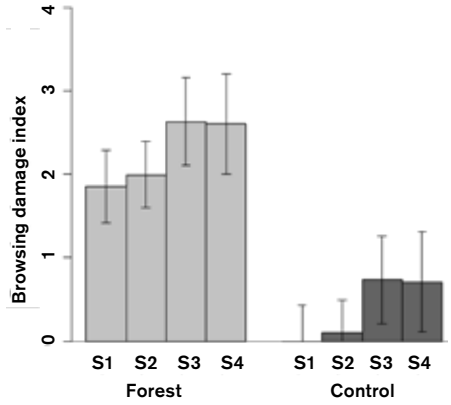


Figure 4. Estimates of mean browsing damage level ± 95 % CI for aspen (on a scale from 0 (unbrowsed) to 4 (every long shoot browsed) per plot, in four forest and control strata S1 (< 30 m a.s.l.), S2 (30 < 200 m a.s.l.), S3 (200 < 400 m a.s.l.) and S4 (> 400 m a.s.l.). Rowan, sallow, oak and Scots pine show the same pattern.

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

## Governance and management

To support knowledge production about the integrated management of large carnivores, large herbivores and cascading effects on forest ecosystems and their ecosystem services, we encourage researchers to carry out macroecological comparative studies that include variation in both landscape history, and different governance and management regimes. This provides opportunity for initiating a process of collaborative learning among actors and stakeholders with different portfolios of landscape benefits. Future research should thus turn the focus from the ecology of large herbivore-forest systems only towards also the human and societal aspect of how to best govern and manage these systems (Figure 5). The variation among countries in the Baltic Sea Region is a great asset for this ■

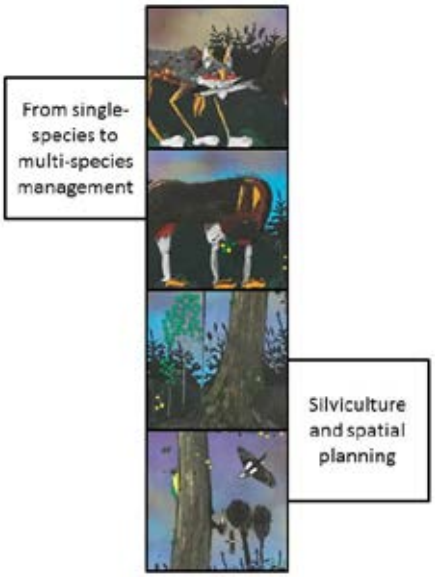


Figure 5. Managing trophic interactions requires integration of the management of wolf, moose and the cascading effects on other species, but also the entire forest landscape. This requires new forms for integrated landscape stewardship. Illustration by Per Angelstam and Andreas Öster.

**Keywords**
Moose, wildlfe management, forestry, spatial planning, biodiversity, macroecology, collaborative learning.

**Read more**

‣**Angelstam, P. & Elbakidze, M. 2017.** Forest landscape stewardship for functional green infrastructures in Europe's West and East: diagnosing and treating social-ecological systems. In: Bieling, C. & Plieninger, T. (eds.) The Science and Practice of Landscape Stewardship. Cambridge University Press, pp 124–144.

‣**Angelstam, P., Manton, M., Pedersen, S. & Elbakidze, M. 2017.** Disrupted trophic interactions affect recruitment of boreal deciduous and coniferous trees in northern Europe. Ecological Applications 27(4): 1108–1123.

‣**Angelstam, P., Pedersen, S., Manton, M., Garrido, P., Naumov, N. & Elbakidze, M. 2017.** Green infrastructure maintenance is more than land cover: large herbivores limit recruitment of key-stone tree species in Sweden. Landscape and Urban Planning 167: 368–377.

‣**Angelstam, P., Wikberg, P.E, Danilov, P., Faber, W.E. & Nygrén, K. 2000.** Effects of moose density on timber quality and biodiversity restoration in Sweden, Finland and Russian Karelia. Alces 36:133–145.

**Authors**

**Per Angelstam**
Professor,
Swedish University of Agricultural Sciences, School for Forest Management, SE-73921 Skinnskatteberg
per.angelstam@slu.se

**Michael Manton**
Researcher,
Aleksandras Stulginskis University, Institute of Forest Biology and Silviculture, LT-53362, Akademija, Kauno r.,Lithuania
michael.manton@asu.lt

**Simen Pedersen**
Førsteamanuensis,
Inland Norway University of Applied Sciences, Department of Forestry and Wildlife Management, Evenstad, NO-2480, Koppang, Norway
simen.pedersen@inn.no

**Marine Elbakidze**
Associate professor,
Swedish University of Agricultural Sciences, School for Forest Management, SE-73921 Skinnskatteberg
marine.elbakidze@slu.se

**FOREST FACTS** – Results from the Swedish University of Agricultural Sciences
**ISSN:** 1400-7789. **Production:** SLU, Faculty of Forest Sciences 2017.
**Responsible editor:** Goran.Stahl@slu.se.
**Editor:** Goran.Sjoberg@slu.se.
**Illustrator:** Fredrik Saarkoppel, Kobolt Media AB. **Print:** TMG Tabergs. **Subscription:** www.slu.se/faktaskog