

# ShortCuts

FROM SKOGFORSK. NO 3 | 2016 | RESEARCH FOR TOMORROW'S FORESTRY

**10** RESULTS  
THAT MAKES  
A DIFFERENCE

**20** YEARS OF  
DECLINING  
EFFICIENCY

*How to save*

## SCOTS PINE IN A NEW CLIMATE

RESEARCH COLLABORATION WITH CHILE | SEK 40 MILLION TO SUSTAINABLE FORESTRY

OPTIMISATION GIVES SMARTER FUEL TRANSPORTS | RESEARCHERS CRITICAL TO WATER FOOTPRINT INDICATOR

DREAM OF A ROT-RESISTANT NORWAY SPRUCE | SAME GENETIC DIVERSITY IN MANAGED AND NATURAL FORESTS

BETTER CONSERVATION WHEN BIOGEOGRAPHICAL REGIONS ARE CONSIDERED | NEW STUDY GENERATES HOPE FOR THE ASH

PRIORITIZING DITCH CLEANING | REDUCED DRAG BENEFITS THE ENVIRONMENT AND COSTS

# TOUGH GOING

## *Declining efficiency in forestry*



Work to improve efficiency in Swedish forestry is struggling to keep up with rising costs and falling timber prices in real terms. The trend has been the same for the past 20 years. This is shown in Skogforsk's Forestry Index – a new way to measure the economic efficiency of forestry.

*Text & photo* SVERKER JOHANSSON | sverker@bitzer.se

■ “You could say that the wood value continues to decrease, while forestry is struggling to improve efficiency at the rate required to maintain profitability,” says Rolf Björheden, head of Skogforsk's Forest Technology and Machinery research area.

The new Forestry Index expresses wood value to roadside in relation to costs. Forestry costs include felling, forest transport, silviculture, roads and administration, so the index identifies the overall economic efficiency per cubic metre.

Together with detailed information from surveys and official statistics on costs and revenues, productivity in different operations, and utilisation rate of forest machines, the Forestry Index helps give a more complete picture of productivity trends in forestry.

### Falling trend

The Forestry Index is expressed in relative figures, and has varied between 1.9 and 2.6 in the past 20 years. The index increased from 1996 to 1999, but has since fallen, with short-term fluctuations linked to the economic cycle. In recent years, the index has fallen below 2, and the downward trend seems likely to continue.

Although wood prices have fallen in real terms by 1-2 percent since the 1950s, the forestry sector has compensated for this and rising labour costs by improving efficiency. However, Rolf Björheden does not believe that technological development alone can ensure continued profitability in forestry.

“As the sector became more mechanised, we often saw a ten percent increase in efficiency

with every new machine generation. But now we're talking in terms of perhaps 1-2 percent, and at a considerably higher development cost.”

### New approaches

“Technology development must be supplemented with alternative approaches,” continues Rolf Björheden. “It doesn't involve anything new, but we must improve when it comes to disseminating knowledge and implementing good examples in practice.”

“Forestry can make better use of the existing wood value and, with better measurement and handling, combined with good flow controls, the sector can ensure that the wood reaches the right user,” he explains. “I believe that forestry organisation can be streamlined in terms of how different parties collaborate in the production chains, both within and across company boundaries. And well-stocked, well-managed forests are, of course, vital.”

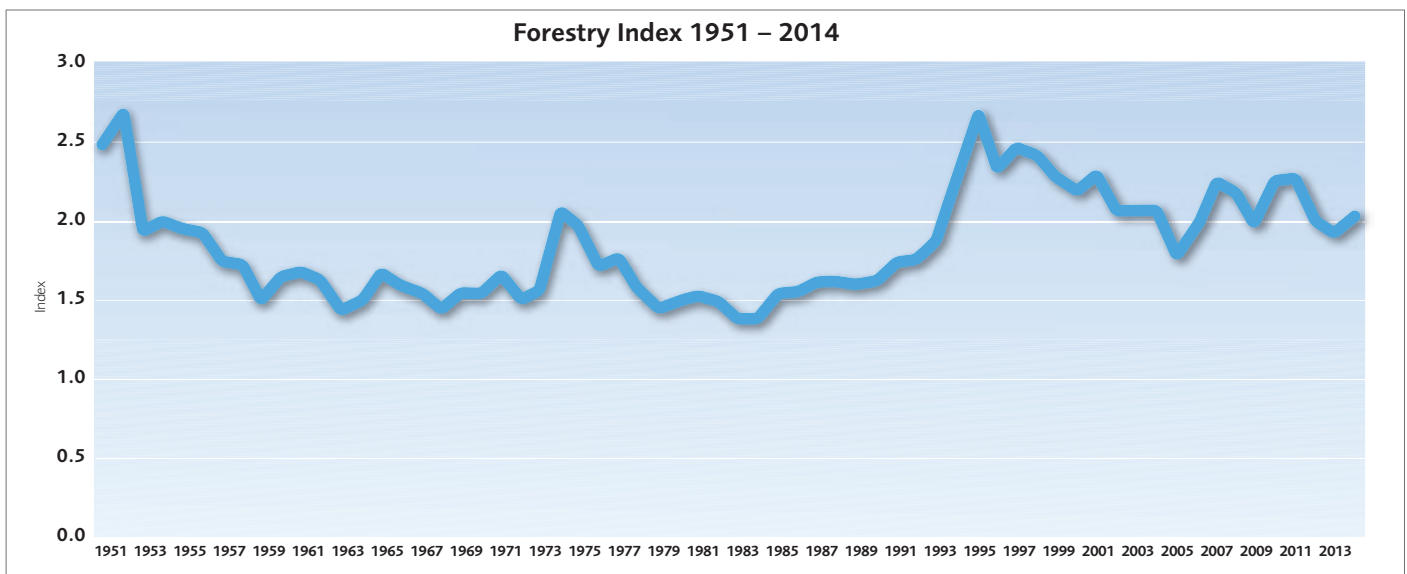
Rolf Björheden points out

**“We must improve when it comes to disseminating knowledge and implementing good examples in practice”**

ROLF BJÖRHEDEN

how crucial forestry efficiency is for sustainable development in society.

“Such great hopes are pinned on the importance of the forestry sector in driving the transition to the new bioeconomy, so forestry itself must be sustainable, even in less productive harvest districts far from the mills and heating plants.”



Forestry Index since 1951. Historically, the index has looked relatively healthy after successful efficiency improvements in the 1980s and 1990s, but in the past 20 years the trend has been negative. Something must be done.



# SEK 40 MILLION TO SUSTAINABLE FORESTRY

After a new investment of SEK 40 million over three years from the EU and forestry companies, Skogforsk and partners will be developing and testing new technology and knowledge relating to sustainability in European forestry. The work will be carried out as part of the EFFORTE research and innovation project.

■ The entire forestry supply chain from seed to industry gate can be made more efficient and more profitable, and environmental impact reduced, by utilising the digital revolution, combined with the best available knowledge, smart technology, and a distinct systems approach.

Two areas that can benefit from the massive amount of information now being collected from aircraft, satellites and forest machines are silviculture and logging planning.

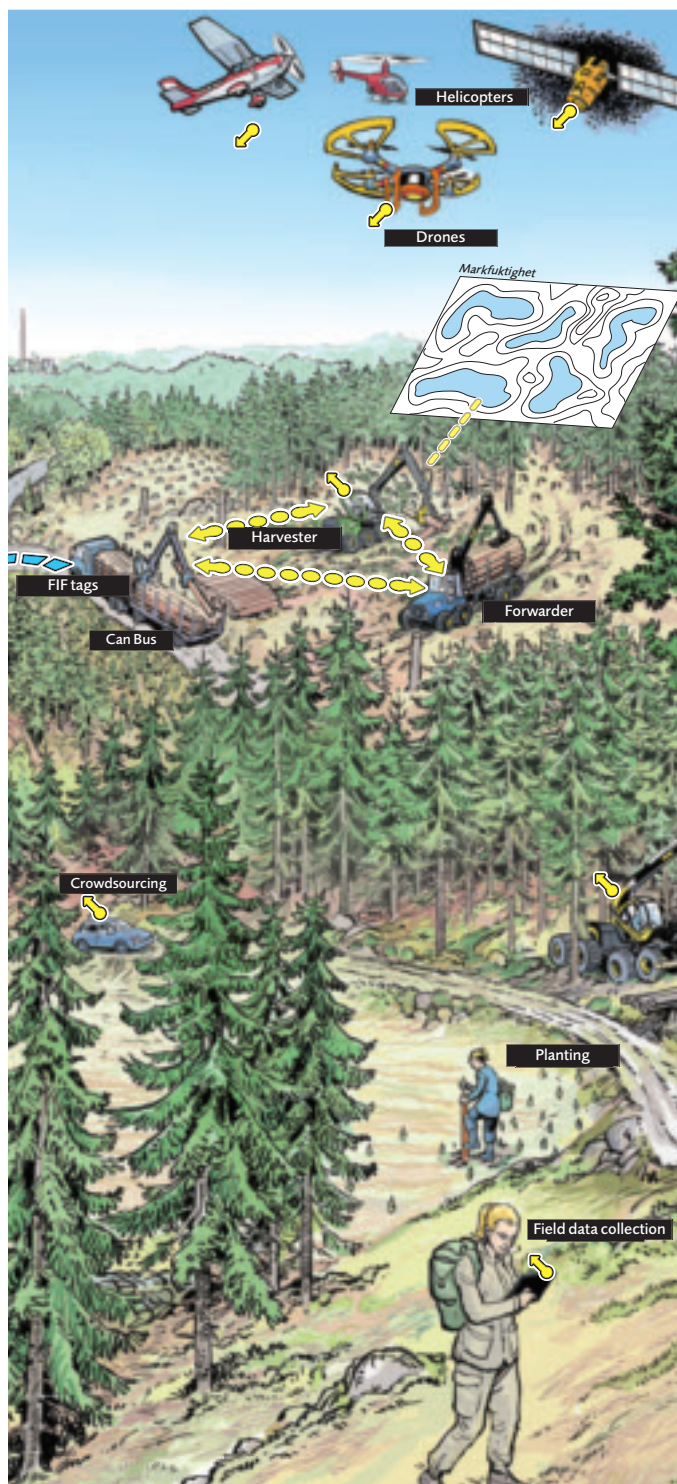
“Within the project, we hope to develop efficient methods for mechanised silviculture and planning methods for efficient and customer-oriented harvest of forest with less environmental impact,” says Magnus Thor, research director at Skogforsk.

“We believe that the results will give Sweden and Europe greater access to, and more efficient utilisation of, the renewable raw material and bioenergy from forests. The results may also help to reduce

global climate impact, develop rural areas, and increase site-specific protection of soil, water, biodiversity and sensitive environments,” says Skogforsk chairman, Göran Örländer.

The funding, which will enable Skogforsk to expand research in some key, highly relevant fields, will be a welcome contribution when the institute compiles funding solutions ahead of the new four-year framework period, 2017-2020. Framework funding is provided by the forestry sector, the state via the Swedish Research Council Formas, commissioned assignments, and EU collaborations like EFFORTE.

The EFFORTE research and innovation project is led by the Natural Resources Institute Finland (Luke). The collaboration project is run by research organisations, forest and industry companies, and development-oriented companies in Sweden, Finland, France and the UK.



A happy man. Magnus Thor is delighted by news of the new research funding.

Here, ShortCuts lists ten research articles published during Skogforsk's most recent funding period, 2013-2016, that made a difference in terms of practical implementation in forestry or as a basis for further research and development.

"We want to show the breadth in our research, and the importance that individual research results can have for developments in forestry," says Marie Larsson-Stern, research director at Skogforsk. "The articles are in no particular order."

She wants to ensure that results from Skogforsk's research are disseminated and make a difference in the sector.

"These articles are just a few examples, but all of them have contributed to important new knowledge and practical solutions, or led to changes in legislation. And, not least, stimulated new research ideas."

She also emphasises that research and development is rapidly becoming a team sport requiring collaboration over national boundaries and between disciplines. It is therefore

important for Skogforsk to participate in international research networks and partnerships with industry. And to be noticed in the research world.

"It's positive that so much of our research is published in prestigious journals. This guarantees that our articles are both scientifically reviewed and exposed to the research community. But exposure in more specialised journals can also be effective in reaching those who benefit from the results."



Marie Larsson-Stern, Skogforsk.

# 10

# RESULTS

*that made a difference*

Text MATS HANNERZ | Photo SVERKER JOHANSSON/bitzer.se

## Standardised machine costs enable international comparisons

■ What new machine should my company buy? How much should I be paid as a contractor? What does felling cost for me as forest owner? And how can I, a researcher, compare profitability for machines and methods?

Cost calculations can be difficult enough to carry out within the same country but, over national boundaries, it is even harder. How can you consider different tax systems, fees, subsidies and regulations regarding salaries and other remuneration when comparing costs?

Researchers, clients and producers have been grappling for many years with the problems associated with international price comparisons. Skogforsk has participated in a European Cooperation in Science and Technology (COST) project, which developed a standard for transparent cost calculations for forestry machines in different

countries. In the article, the authors describe the model, and the reader can also download a Microsoft Excel file with the entire costs calculation. Free of charge!

### Benefits

"This model has the potential to become an international standard for machine cost calculations. It is already used today in many national and international research institutes. It will probably influence FPIinnovations new cost calculation template as well," says Lars Eliasson, Skogforsk, one of the authors behind the article.

### Article

Ackerman, P, Belbo, H., Eliasson, L., de Jong A., Lazdinis, A. & Lyons, J. 2014. The COST model for calculation of forest operations. *International Journal of Forest Engineering* 25(1), 75-81.



Size matters. Mikael Karlsson was the test operator when Skogforsk compared machine sizes.



## New models save the Scots pine from climate warming

■ Cross-border, climate-adapted deployment recommendations for Scots pine. This is the result of a long-term collaboration between Skogforsk, SMHI, Rosaby Centre and the Natural Resources Institute Finland Luke. The calculations are based on data from over half a million trees in Finland and Sweden. Using 22 climate variables transfer effects models for growth and survival of Scots pine under both current and future climatic conditions were developed. The models are valid in both Finland and Sweden for contemporary genetically improved Scots pine plant material. In the models, the temperature sum is most important for describing the site, and latitude (photoperiod) the most important for describing transfer effects.

### Benefits

Climate adaptations are already being implemented in practice, as effects of climate changes were included in the Swedish decision support tool plantval ('planter's guide') 2011. The tool is used by nurseries and plant buyers. In October, a new version of plantval Tall ('planter's guide – Scots pine'), which includes the recently developed



models, was launched. The models are also used in Finland, where the deployment areas for Scots pine have recently been adjusted northwards. "In early 2017, we'll also be launching a joint version of plantval Tall for Finland and Sweden. Our results show that Finnish seed orchard crops can be used in Sweden and Swedish orchard crops in Finland. pine genes aren't bothered about national boundaries," says Mats Berlin, who coordinates the work with climate adaptation of genetically improved material.

### Article

Berlin, M., Persson, T., Jansson, G., Haapanen, M., Ruotsalainen, S., Barring, L. & Andersson Gull, B. 2016. Scots pine transfer effect models for growth and survival in Sweden and Finland. *Silva Fennica* 50(3), article id 1562.

## Optimisation gives smarter fuel transports

■ Forest fuel will play an important role in Sweden's transition to an energy supply free of fossil fuels. However, forest fuel is bulky, has low value compared to roundwood, and struggles to compete with other energy sources. The buyers have almost negligible capacity to pay more, so the only way to improve profitability is by reducing the cost of the raw material. One key component here is transport, because transport accounts for one-fifth of the forest fuel cost to the customer.

Optimisation experts linked to Skogforsk have analysed all forest fuel transports in Sweden over one year, using data from the IT hub of the forestry sector, SDC.

The data derived from 58,000 harvests, 200,000 transports, and 647 recipients in the form of terminals or heating plants. The results show there is potential to make forest fuel transport more cost-effective. Transport costs can be reduced by five percent through optimised transports

within companies, three percent by making better use of seasonal variations, seven percent by coordinating different assortments, and six percent through collaboration. Potential savings in total are no less than 22 percent.

### Benefits

"Forest fuel is in a tough position today, in competition with other



energy sources. At the same time, there's so much energy potential in our growing forests. Our optimisation solutions are now helping the forestry sector improve planning throughout the supply chain," says Mikael Rönnqvist, Professor in Optimisation, who has collaborated with Skogforsk for many years.

### Article

Flisberg, P., Frisk, M., Rönnqvist, M. & Guajardo, M. 2015. Potential savings and cost allocations for forest fuel transportation in Sweden: A country-wide study. *Energy* 85, 353-365.

## Researchers critical to water footprint indicator

■ A person's ecological footprint is a measure of the amount of resources they use. The same concept is used for water. The water footprint describes the amount of water that is consumed when producing a product or a service.

However, the concept presents something of a problem when it comes to forestry. The water footprint considers evapotranspiration as consumption, and that is one of the largest items when the footprint is applied to Swedish forests.

In this article, the researchers criticise the use of the water footprint for forests in regions with high rainfall. They argue that evapotranspiration is a natural part of the water cycle, and should not be included in the footprint for these types of forest. Evapotranspiration takes place even in unmanaged forest, and water is returned to the forest as precipitation. Evapotranspiration should therefore not be regarded as consumption, say the researchers.



Eva Ring, water researcher, Skogforsk.

### Benefits

"Our research has helped explain the water cycle in forests in Norway, Sweden and Finland, and the role of the forest in this system. You can't use the same measure for a managed Swedish forest as for an irrigated cotton plantation," says Eva Ring, water researcher at Skogforsk.

### Article

Lauiniainen, S., Futter, M.N., Ellison, D., Clarke, N., Finér, L., Högbom, L., Laurén, A. & Ring E. 2014. Is the water footprint an appropriate tool for forestry and forest products: The Fennoscandian case. *Ambio* 3, 244-256.

## Dream of a rot-resistant Norway spruce

■ Root rot does not develop equally quickly in all trees due to genetic variation, so there is potential to breed spruce trees with greater resistance through genetic improvement. Researchers in Skogforsk's tree breeding programme for Norway spruce (*Picea abies*) have been collaborating for many years with researchers at, for example, SLU, to investigate the relevant genetic relationships.

The researchers used progeny from two of the breeding population's parent trees to construct a consensus linkage map for *Picea abies*. This enabled them

to, for the first time, identify some of the DNA sequences that are related to resistance traits. The researchers found a total of 13 marker genes that they will continue to study.

### Benefits

Malin Elfstrand, molecular biologist and expert on root rot at SLU, is collaborating with Skogforsk on the genetic mapping. She explains that the identified marker genes are now being examined in more detail in spruce trees from the TreO seed orchards that are being tested for resistance to root rot.

"Molecular markers for



PHOTO: SKOGFORSK

resistance can be used in plant breeding. We may not be able to breed completely rot-free spruce trees, but the markers we have identified can be used, for example, to screen young plants, so

we can reject those with the lowest resistance," she explains.

Bo Karlsson, spruce breeder at Skogforsk, points out that even small advances can be of major significance.

"If plant breeders can succeed in reducing the incidence of rot by even just a few percent, that means a lot for forestry," he says.

### Article

Lind, M., Källman, T., Chen, J., Ma, X-F., Bousquet, J., Morgante, M., Zaina, G., Karlsson, B., Elfstrand, M., Lascoux, M. & Stenlid, J. 2014. A *Picea abies* linkage map based on SNP markers identifies QTLs for four aspects of resistance to *Heterobasidion parviporum* infection. *PLoS ONE* 9(7): e101049. doi: 10.1371/journal.pone.0101049.

## Same genetic diversity in managed and natural forests

■ What happens to the genetic diversity in trees when we start to manage a forest? This is an important issue that affects the ability of forest to adapt in the long term, for example to a changing climate. If too few trees are parents, more of the offspring are related, reducing the genetic diversity.

In a joint study carried out by Skogforsk and SLU, genetic diversity at DNA level has been compared between unmanaged natural forest, seed-tree regeneration, and regeneration with genetically improved pine trees. The study was carried out using genetic material from pine stands in three regions in northern Sweden. Samples were collected from a total of 196 evenly-spaced trees in each of the three types of stand in each region. The DNA from cell nuclei, chloroplasts and mitochondria was investigated using genetic markers called microsatellites.

Results showed no difference between the managed and natural stands in terms of degree of inbreeding and the proportion of rare and unique genetic diversity. It is assumed that sufficiently many parent trees have contributed to the current

tree generation, so the genetic diversity stays at the same level.

### Benefits

"One important finding is that genetic diversity in forests established with genetically improved plants from seed orchards is at least as great as that found in natural stands. Furthermore, the degree of relatedness among parents of the seedlings arising from orchard seed is similar to that of seedlings from natural regeneration. These results support our long-held belief that genetic structure and diversity of managed stands established with improved orchard material are very little changed from the natural forest."

The explanation is from Tim Mullin, Skogforsk, one of the authors. He also points out that the study is unique – he is not aware of any similar study that has used such good genetic material and replicated stand management conditions.

### Article

Garcia Gil, M.R., Floran, V., Östlund L., Mullin, T.J. & Andersson Gull, B. 2015. Genetic diversity and inbreeding in natural and managed populations of Scots pine. *Tree Genetics & Genomes* 11: 28. doi:10.1007/s11295-015-0850-5.

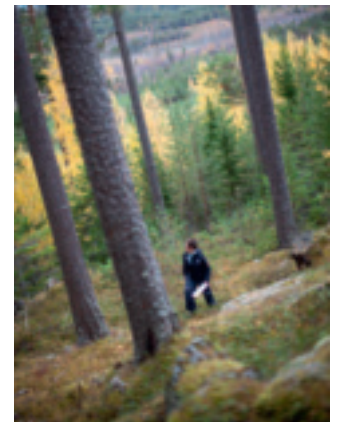
## Better conservation when biogeographical regions are considered

■ From the deciduous forest landscape of southern Sweden to the coniferous forest belt in the north, there are great variations in forest dynamics, past land use, climate and ownership structure. Yet regulations and strategies for tree retention and conservation are almost standard over the whole country.

In the article, conservation scientists from different parts of Sweden argue that regional differences need to be better incorporated in strategic conservation planning. They present a decision support model showing how biogeographical variations can be given greater weight in conservation strategies and policies. The model begins by formulating overarching objectives for conservation policy. These objectives are then broken down into regional goals and descriptions of the conditions in the biogeographical region. Better adaptation of conservation measures to regional variations would make the measures more effective.

### Benefits

"The study has led to a project in which Sweden will be divided into



biogeographical regions, and this will mean that conservation can be adapted to the local conditions during harvesting. One example is to prioritise the habitats that are particularly important to preserve in different parts of the country," says Lena Gustafsson from SLU.

### Article

Gustafsson, L., Felton, A., Felton, A.M., Brunet, J., Caruso, A., Hjalntén, J., Lindblad, M., Ranius, T., Roberge, J-M. & Weslien, J. 2015. Natural versus national boundaries: the importance of considering biogeographical patterns in forest conservation policy. *Conservation Letters* 8, 50-57.



## New study generates hope for the ash

■ Many people are worried that the ash will suffer the same fate as the elm with its Dutch Elm Disease. The first incidences of dieback damage were reported 2001-2002, and within five years the disease had spread throughout the range of the tree species in Sweden.

Skogforsk assessed the damage and mortality in the two ash seed nurseries, Snogeholm and Trolleholm in Skåne. The grafts originated from 106 plus-tree clones selected from 27 stands in southern Sweden.

The analysis showed that no ash clones were completely resistant, but that there was a strong genetic component in resistance to the disease. Consequently, by selecting healthy individuals and using traditional genetic improvement, there is hope for the ash.

This scientific article was the most downloaded article in the Scandinavian Journal of Forest Research, with 4500 viewings in



Not just the wood is under threat – the ash is part of our cultural heritage.

a short time, and the article has been cited many times by other researchers. The study has also stimulated similar studies, such as in Denmark and Lithuania.

### Benefits

"The study was one of the first that considered genetic differences in dieback, and it also had a statistically robust experimental design. Today, we know that damage can be slowed by selecting fresh individuals. Skogforsk has now registered over 500 healthy ashes in stands from Skåne in the south to Uppland in central Sweden. In a few years, we will inspect the trees again.

"The idea is that we will carry out artificial resistance tests, and then use the most resistant clones in new seed nurseries," says Lars-Göran Stener.

### Article

Stener, L-G. 2013. Clonal differences in susceptibility to the dieback of *Fraxinus excelsior* in southern Sweden. *Scandinavian Journal of Forest Research* 28(3), 205-216.

## Prioritizing ditch cleaning

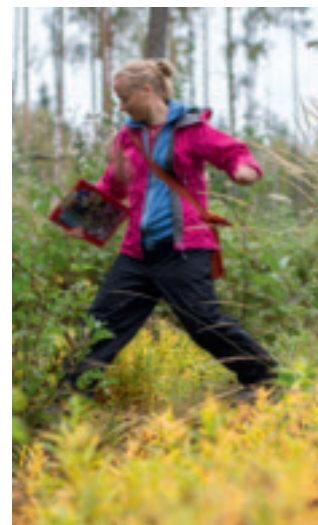
■ Cleaning ditch networks can stimulate tree growth. This has been confirmed in the new review of current knowledge that Skogforsk has compiled together with the Natural Resources Institute Finland (Luke).

In pine forest on peat soils, growth responses of 0.5-1.8 m<sup>3</sup> per hectare and year have been measured over 15-20 years after ditch maintenance. One important finding is that ditch cleaning has little effect if the stand volume exceeds approximately 150 m<sup>3</sup> per hectare. The effect on growth also seems to be small or negligible if the original groundwater level is deeper than 30-40 cm below the surface. Ditch cleaning should therefore be prioritised during final felling or thinning of young forest.

### Benefits

"The results show that stand development is very important for soil water conditions, and that ditch maintenance has most effect at the start of the rotation. This will help us make better choices about the stands in which ditches should be maintained," says Ulf Sikström, Skogforsk.

The article also points out the lack of experimental results from Sweden – all growth studies were



carried out in Finland.

"We've started to plug this knowledge gap with a study of 14 stands where ditch networks have been cleared and cleaned, from Överkalix in the north to Nybro in the south. We're using tree ring analysis to try to estimate the effects on growth," continues Ulf Sikström.

### Article

Sikström, U. & Hökkä, H. 2016. Interactions between soil water conditions and forest stands in boreal forests with implications for ditch network maintenance. *Silva Fennica* 50(1), article ID 1416.

## Reduced drag benefits the environment and costs

■ For many years, truck manufacturers have been looking at how aerodynamic design can reduce fuel consumption. The cabs have been given a softer and more wind-deflecting outline, but little attention has been paid to the effects on air resistance when the vehicle is expanded into an entire timber rig. There are many parts of a timber truck that retard the vehicle – trailer, load, stakes and cranes. This article shows how simple wind deflection solutions can reduce fuel consumption, and thereby

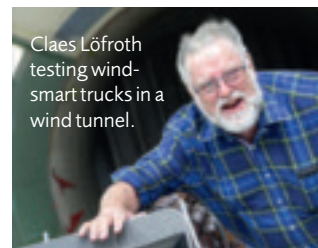
costs, as well as reducing environmental impact.

The studies were carried out by Skogforsk together with truck manufacturers, component manufacturers and Linköping University. The model, built to scale, was tested in a wind tunnel. The tests showed how fitting wind deflectors on the cab, folding down the stakes when driving unloaded, and covering the space in front of and between the stacks can considerably reduce aerodynamic drag.

### Benefits

"The studies were part of the ETT project, where we tested longer and heavier vehicles. In the ETT-Aero project, the wind tunnel tests showed great potential, with drag reduced by up to 20-25 percent and fuel consumption by 10 percent. Now we're moving on to more detailed tests. Our wind-deflecting attachments will be fitted on three vehicles to see what gains we can achieve in practice," explains Claes Löfroth, road transport expert at Skogforsk.

"One interesting point is that Scania released its first new truck for 20 years at the end of the summer," he continues. "They've put a lot of work into the aerodynamics, and



Claes Löfroth testing wind-smart trucks in a wind tunnel.

their engineers also participated in the wind tunnel project described in the article."

### Article

Löfroth, C., Karlsson, M., Gårdhagen, R., Ekman, P. & Söderblom, D. 2015. Aerodynamics of timber trucks – a wind tunnel investigation. *SAE Technical Paper* 2015-01-1562. doi: 10.4271/2015-01-1562.



**RESEARCH  
COLLABORATION  
WITH CHILE**

# KNOWLEDGE EXCHANGE ON SUSTAINABLE FORESTRY

Charlotte Bengtsson, Rodrigo Mujica, Jerry Bohlin and Magnus Thor discuss felling methods.

■ The Swedish and Chilean governments have agreed that the two countries will strengthen research relationships and share knowledge about sustainable forestry. One area for collaboration is sustainable forest management and forest fuel.

In June, Skogforsk hosted a visit from three representatives of the Chilean forest research institute, Instituto Forestal (INFOR): Rodrigo Mujica, Vice Manager, Susana Benedetti, Research Manager, and Hans Grosse, Head of International

Contacts. The programme comprised two days of knowledge exchange. “Strong international networks are a success factor for research institutes like Skogforsk,” says Charlotte Bengtsson, CEO of Skogforsk. “For us they are an integral part of our

situation analysis, benchmarking and skills provision. It also gives us an opportunity to share our knowledge about Swedish sustainable forestry and our experiences of how to organise and fund Swedish research in this area.”



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