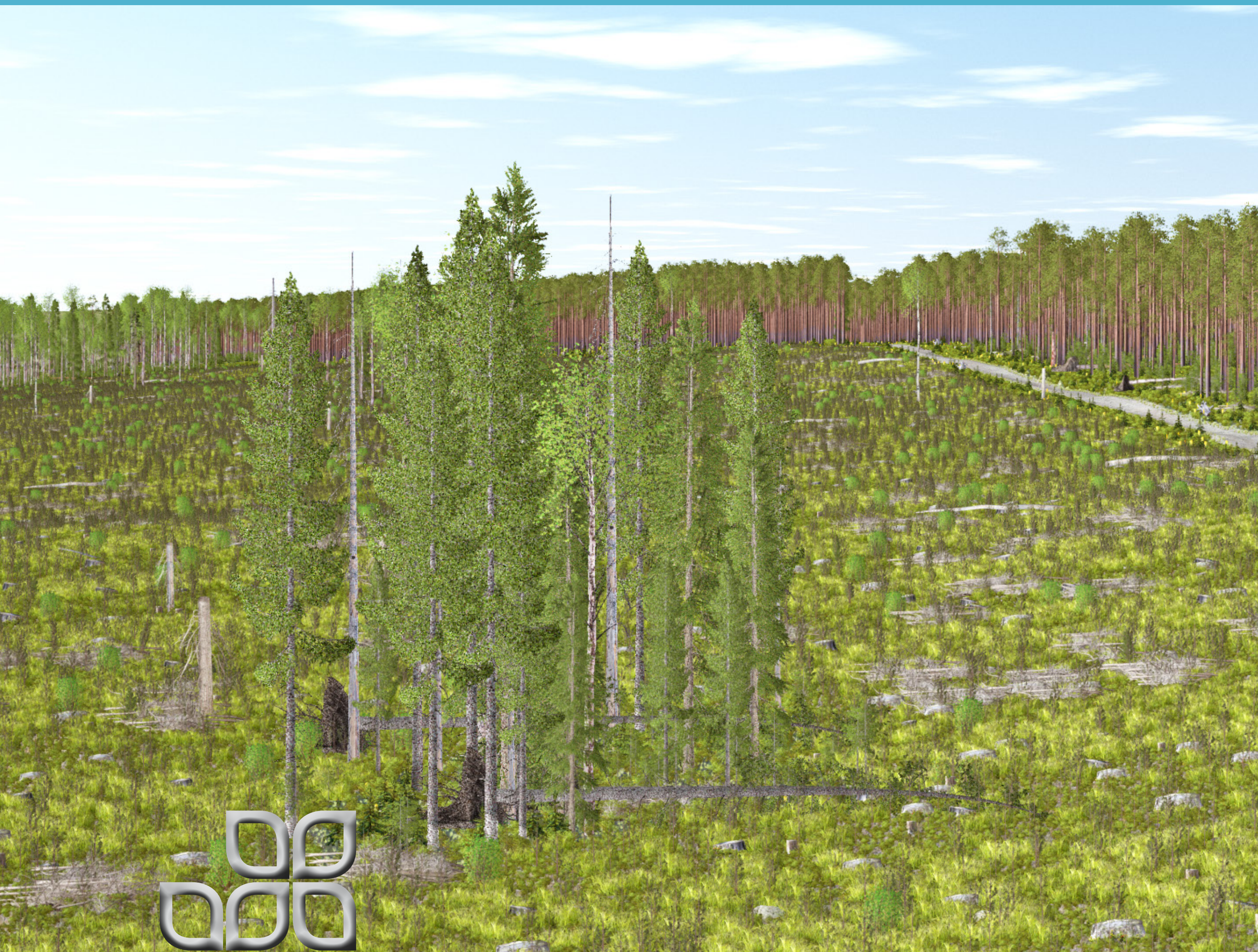
SLU

Department of Forest Resource Management



Annual Report 2013

SP Certified ISO 14001

Johan Fransson
Head of Department

Contents

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Emma Sandström, SLU.
Publisher:
Johan Fransson, SLU.
Editor and Layout:
Emma Sandström, SLU.

Dear Reader,

It is time for the Department of Forest Resource Management to say goodbye to the year 2013 and welcome 2014! As usual it has been a fruitful year with a lot of achievements worth pointing out. On the following pages I will attempt to briefly describe the main achievements of the Department.

The Annual Report is divided into the main fields of activities of the Department: Undergraduate, Master's and Doctoral studies, and research within five competence areas, as well as three major environmental monitoring programs. Also included in this report are the schematic view of the Department's organization, Department photos, press clippings, facts and figures, and major activities of the Forest Sustainability Analysis program and the Department's environmental management system followed by a compilation of publications and names of the field staff.

From 1 January Peter Högberg was appointed as the new Dean of the Faculty of Forest Sciences, following this there were changes in the Faculty's management. The start of the new three years term also gave rise to changes in the Department's management such as a few new staff members in the Department steering committee (see events with respect to the staff during 2013 below).

In January, the Department underwent changes with respect to the Unit of Forest Technology, with approximately 20 staff members, moving to the newly established Department of Forest Biomaterials and Technology. We wish our former colleagues and their new department the very best of luck! Another significant change is also that the competence area of Mathematical Statistics Applied to Forest Sciences from this year onwards belongs to our Department. Therefore, important activities during the year have been the process of advertising and recruiting of a new professor to lead the competence area. We are looking forward to the decision concerning this professorship that will be taken by the Faculty in the beginning of 2014! Next year we will start reporting from this competence area in the Annual Report.

The working committees of System Development and Information Technology were closed during the year and a new working committee called System Development and Information Technology was introduced. In October, we were privileged to celebrate the 90th anniversary of the Swedish National Forest Inventory with a number of distinguished guests invited to dinner. The year 2013 was the first year of the Department's new goals and strategies document spanning the period 2013-2015. From now on, the goals and strategies document act as the steering document for the Department's environmental management system. To our great joy the Department was recertified for our environmental management system during 2013 by the new certifier SP. Therefore, a new logo is found on the cover of this report!

All of the Department's achievements are, of course, based on a combination of individual and team efforts, contributions that all definitely deserve to be mentioned. This is unfortunately an impossible task. Nevertheless, I would like to highlight a few important events with respect to the staff during 2013:

- Sören Holm retired after serving SLU for more than 30 years
- Jonas Fridman was appointed as Deputy Head of Department
- Per Nilsson was appointed as Head of the Section of Forest Resource Data
- Heather Reese was appointed as Head of the Section of Forest Remote Sensing
- Åsa Eriksson was appointed as Head of the Section of Landscape Analysis
- Johan Svensson was appointed as Vice Head of Environmental Monitoring and Assessment
- Erik Wilhelmsson was appointed as Vice Head and Director of Undergraduate and Master's Studies
- David Alger was appointed as Chairman of the new working committee of System Development and Information Technology
- Johan Holmgren and Eva Lindberg published a paper in the Canadian Journal of Remote Sensing and received their "Best Paper of 2013" award
- Bertil Westerlund was honored in a special celebration for employees that have served the government for 30 years

I hope you will enjoy reading this Annual Report and do not hesitate to contact us if you would like to find out more about the activities touched upon here. We would be more than pleased to share our knowledge and experiences with you!

Yours sincerely,

Johan Fransson
Head of Department

Organization

Schematic View of the Department

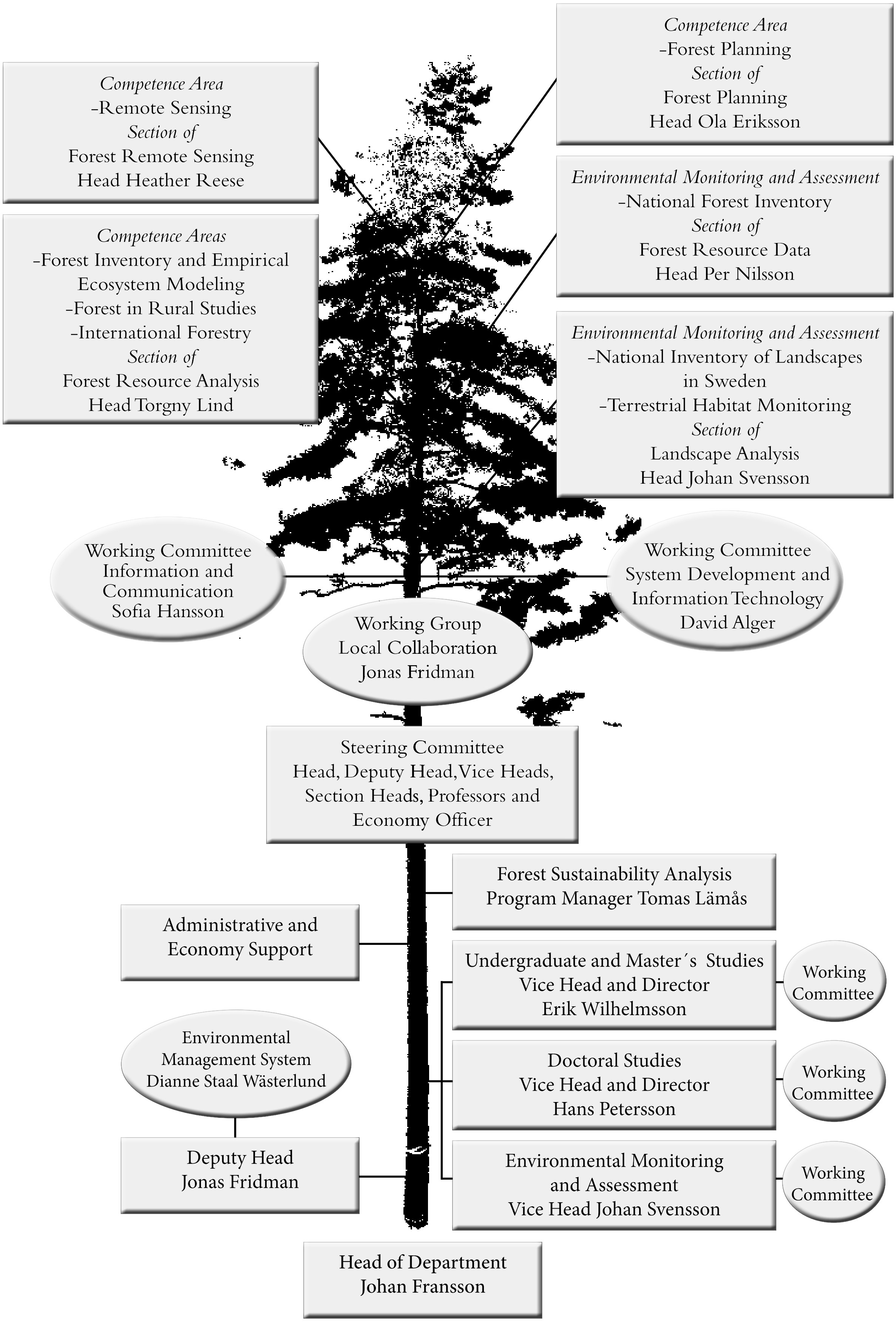


Figure:
Kenneth Olofsson, SLU
and Emma Sandström,
SLU.

Department Photos

Department Steering Committee

In the photo:
Dianne Staal Wästerlund
Ola Eriksson
Jonas Fridman
Per Nilsson
Hans Petersson
Arne Pommerening
Heather Reese
Thomas Kronholm
Åsa Eriksson
Pär Andersson
Johan Fransson

Missing:
Torgny Lind
Håkan Olsson
Göran Ståhl
Erik Wilhelmsson

The duties of the Department Steering Committee are to identify key issues and define the Department's position on strategic and comprehensive questions. The responsibilities also include supporting the management of the Department. The committee convened on a weekly basis and also had seven more indepth meetings during 2013.

Administrative and Economy Support

In the photo:
Ylva Jonsson, Economy Administrator
Nanna Hjertkvist, Administrator
Pär Andersson, Economy Officer
Anne-Maj Jonsson, Economy Officer
Linda Ågren, Economist

Missing:
Sofia Hansson, Information Officer
Carina Westerlund, Administrator

The administrative staff are involved in most of the activities within the Department including bookkeeping, employment issues, field administration, student course registration, information issues and layout of reports.

Employees at the Department 2013

On 26 November the staff gathered for a Department day at Umeå Folkets Hus – a facility used for seminars, conferences and cultural events – to discuss this year's theme: SLU and the Department values. The day started with a follow-up regarding the work environment and the move to our newly renovated facilities, followed by lecturer and discussion about SLU and the Department values.

Text: Johan Fransson, SLU.
Figures: Emma Sandström, SLU and Patrik Umaerus, SLU.

Press Clippings

PlanWise adapts forest management to the owner's long-term goals
The Heureka's Decision Support System—known as PlanWise—now makes strategic analysis possible also for forest owners with 50–500 hectares of forested land. This group of forest owners traditionally only has forest management plans with a ten-year planning horizon even if the ownership period is often much longer. They have had to rely on general guidance for forest management, but they can now optimize the long-term management of their holdings with regard to a precise goal. Goal formulation is a necessity for analysis with Heureka PlanWise, and the system will attempt to find the best management system to achieve these goals.
Published November 2013
Skogssallskapet.se/skogsvarden

More accurate data with remote sensing
It will soon be possible to get more accurate information about Sweden's forests with three-dimensional maps produced by laser scanning. Researchers at the Section of Forest Remote Sensing at SLU in Umeå are currently working on a method to coregister data from airborne laser scanning and data from terrestrial laser scanning in order to obtain estimates of trunk properties for large forest areas.
Published December 2013
Skog & Framtid

City dwellers take over in rural areas
"However, there are other possibilities to make use of the forest as well as other products and services that the forest can contribute to. But here a completely new kind of entrepreneurship, with the forestry or forest property as a base, is needed."
Published 26 December, 2013
Gun Lidestav, interviewed by Sveriges Radio P4 Norrbotten

The Swedish forests are growing fast
Can you see a lot of forest around you? If you can, this is not surprising because 70% of Sweden's land is covered by forest. The volume of forest is increasing rapidly, and according to the Swedish National Forest Inventory's latest report there are over 3 billion cubic meters of forest presently covering Sweden.
Published 17 October, 2013
Jord & Skog

Challenges for the forest owners' association
According to Thomas Kronholm, the forest owners' association will face a number of challenges connected to its member organization's structure and democratic procedures as the forest owner population becomes more urban. The members need to take a more active role in the development of the association by asking themselves what type of organization they want it to be in the future and then working consciously towards this goal.
Published 2013
Norra Skogsmagasinet, No 4

The tools provide more accurate projections
"It has been common to perform separate analyses for different forest uses and with different preconditions, and this has made it difficult to compare the results of different studies. With the Heureka software, analyses can be performed within the same framework," says Tomas Lämås, Program Manager of SLU's Forest Sustainability Analysis program (SHa).
Published 2013
Forum, No 3, Sveaskog

The inventory teams are keeping an eye on Sweden's forests
It's a job someone has to do, and the Swedish National Forest Inventory has been active in a forest near you for the last 90 years. There is a great deal of interest in data about the status, growth, and fellings in Sweden's forests. Since the beginning of the program in 1923, the Swedish National Forest Inventory has collected the field data that forms the basis of many decisions and discussions within the forestry sector. On a national and regional level, politicians, civil servants, and the forestry sector use the data in the follow-up and evaluation of environmental goals. Statistics and measureable variables are fundamental in this kind of analysis.
Published 18 October, 2013
Skogen.se

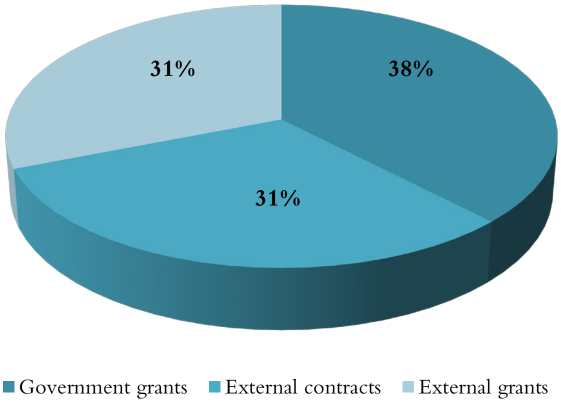
LULUCF & REDD+ Convergence and the International Climate Policy Framework
Are LULUCF and REDD+ adequately mobilized in the International Post-Kyoto Climate Policy Framework? Assuming a transition from "Common but Differentiated Responsibilities" toward "Common and Less Differentiated Responsibilities", are LULUCF and REDD+ compatibly integrated into international carbon-trading schemes and the Post-Kyoto Climate Policy Framework?
Published 18 November, 2013
Side Event to Climate Change Conference, Warsaw

Heureka – balancing forest objectives
"The Heureka system is at the forefront of international developments in this field, with its multi-objective analyses and ability to analyse various forest values on different geographical scales."
Published April 2013
New Insights

Facts and Figures

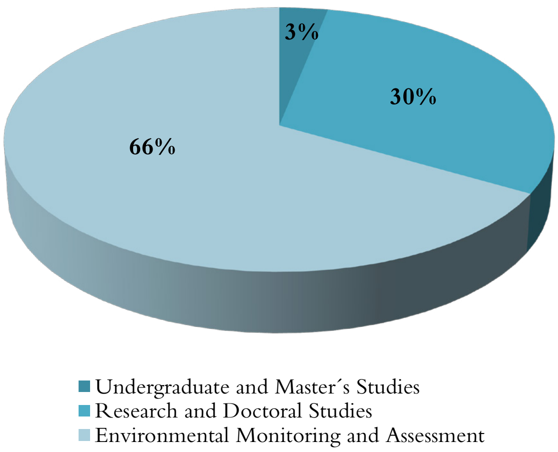
Revenues

Revenues (1000 SEK)	Undergraduate and Master´s Studies	Research and Doctoral Studies	Environmental Monitoring and Assessment	Support Function	Total
Government grants	3 885	15 390	29 841	0	49 116
External contracts	138	3 383	37 180	60	40 761
External grants	144	18 510	21 521	81	40 256
Other revenues	142	9	37	0	188
Total	**4 309**	**37 292**	**88 579**	**141**	**130 321**



Costs

Costs (1000 SEK)	Undergraduate and Master´s Studies	Research and Doctoral Studies	Environmental Monitoring and Assessment	Support Function	Total
Staff	2 377	23 062	54 007	6 694	86 140
Premises	599	1 642	1 995	2 587	6 823
Other operative expenses	314	6 694	15 781	2 615	25 404
Depreciation	0	45	340	47	432
Overheads	854	8 125	15 654	-10 218	14 415
Total	**4 144**	**39 568**	**87 777**	**1 725**	**133 214**



External Contracts and Grants

Financier	Incomings (million SEK)
EU	31.2
Swedish Environmental Protection Agency	14.3
Swedish Forest Agency	5.9
Swedish Board of Agriculture	4.4
Formas	3.3
The Swedish Forest Society Foundation	2.4
County Administrative Boards	2.3
Swedish National Space Board	1.8
Swedish Research Council	1.1
Swedish Energy Agency	0.9
Brattås Foundation	0.8
Swedish Farmers' Foundation for Agricultural Research	0.6
Nils and Dorthi Troëdsson's Foundation	0.6
Swedish District Heating Association	0.4
Sveaskog	0.4
Metria AB	0.3
Norra Skogsägarna	0.3
Önnesjö Foundation	0.3
Forestry Research Institute of Sweden	0.3
Swedish National Land Survey	0.3
MSc European Forestry Consortium	0.2
SCA Forest	0.2
Swedish Forest-Owner Plans AB	0.2
Bergvik Skog	0.2
Saami Parliament	0.1
The Royal Swedish Academy of Agriculture and Forestry	0.1
Holmen Forest	0.1
Ljungberg's Foundation	0.1
Petersson-Grebbe's Foundation	0.1
Metla	0.1
Swedish National Heritage Board	0.1
The National Property Board of Sweden	0.1
The Church of Sweden	0.1
Others	7.4
Total	**81.0**

Personnel Categories

Personnel Categories	Number of Work-Years*
Professors	2.5
Associate professors/University lecturers	10.9
Assistent professors	1.9
Researchers	19.8
Post-doctorates	2.0
Doctoral students**	12.8
Other teachers	1.9
Administrative staff	8.5
Technical staff	34.9
Technical staff (field)	38.8
Total staff	**134.0**

*These figures show the number of work-years at the Department. It's not a true reflection of the number of employees.
** 0.9 work-years are included that relates to persons that didn't have an empolyment.

Tables: Pär Andersson, SLU and Anne-Maj Jonsson, SLU.
Figures: Emma Sandström, SLU.

Undergraduate and Master's Studies

Erik Wilhelmsson
Vice Head and Director Undergraduate and Master's Studies

The Department is a major contributor to SLU's Master of Forestry Program (Jägmästarutbildningen). Our course selection amounts to 40 ECTS credits at the Bachelor's level and 40 ECTS credits at the Master's level. The courses are given in the following subjects: Remote Sensing and Geographic Information Technology (GIT), Forest Inventory, Forest Planning, Mathematical Statistics and Organization and Leadership. The individual courses for each subject are shown in the table below. Courses at the Bachelor's level have 60 to 80 students per course, and courses at the Master's level have 10 to 60 students per course.

Curriculum development is handled by subject co-ordinators Heather Reese (Remote Sensing and GIT), Anna Hedström Ringvall and Torgny Lind (Forest Inventory), Erik Wilhelmsson (Forest Planning), Anders Muszta (Mathematical Statistics), and Dianne Staal Wästerlund (Organization and Leadership).

Highlights for 2013. We performed an external review of the current curriculum and the curriculum development needs in the subjects of Remote Sensing and GIT, Forest Inventory and Forest Planning. We offered a new course called PlanWise as Decision Support in Forestry Planning (7.5 ECTS) for the first time. The course content was developed from a course that was previously offered in the fourth year, but is now offered in the third year. The 63 students were extremely satisfied with the course and gave it an overall assessment of 4.7 out of 5! The course was nominated to SLU for this year's pedagogical prize for excellence. We gave an ERASMUS course in Participatory Planning (5 ECTS) for the third and final time in co-operation with the University of Lapland and University of Tampere in Finland, the Agricultural University of Cracow in Poland, the University of Highlands and Islands in Scotland, and Mendel University in the Czech Republic. This time the course was given in Cracow, the course had previously been given in Rovaniemi in Finland and Brno in the Czech Republic.

The total volume of teaching performed at the Department was 84 full-time equivalents and 71 annual-performance equivalents. Approximately 6.75 full-time equivalents and 6.5 annual-performance equivalents of the total volume came from Master's theses. This means that 11 theses were completed, including 7 in Forest Operations Management. Teachers at the Department also supervised 11.5 Bachelor's theses.

Strategic goals. The long-term goal for educational activities in the Department is to deliver relevant competence to the forestry sector through high-quality instruction. Annual progress towards this goal is measured by a number of performance indicators (Figure 1). These include external and internal participation in curriculum development, number of lecturers in each subject, student course evaluations, and number of Master's theses completed within the Department. We will also seek to get better control of how much time we spend on teaching.

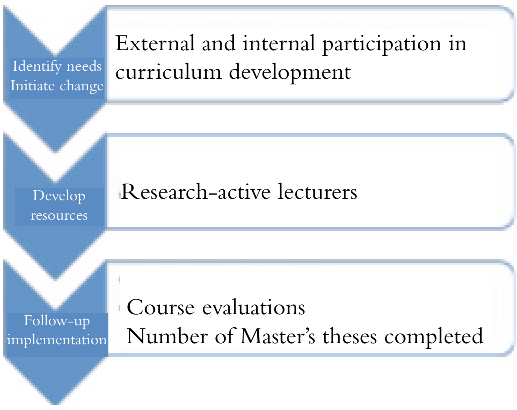


Figure 1. SRH's strategy for education development showing the three main elements (left) and respective performance indicators (right).

Courses Given at the Department in 2013

Subject	**Undergraduate Level** (years 1-3) 60-80 students per course	**Master's Level** (years 4-5) 10-60 students per course
Remote Sensing and GIT	Basic GIT (yr 1) Laser Scanning and Digital Photogrammetry in Forestry (distance course for students at the School of Forest Management in Skinnskatteberg and for forest professionals)	Advanced GIT Forest Remote Sensing
Forest Inventory	Basic Tree and Stand Measurement (in Forest Management and Product Processing, yr 1) Forest Inventory and Statistics (yr 2) Silviculture and Forest Management Planning (yr 3)	
Forest Planning	Forest Planning and Silviculture (yr 2) PlanWise as Decision Support in Forestry Planning (yr 3)	Forest Planning From a Company Perspective (-2013)
Mathematical Statistics	Mathematics (yr 1) Forest Inventory and Statistics (yr 2)	
Organization and Leadership	Individual and Group Leadership (yr 1)	Forestry From an Organizational Theory-Related Perspective
		Trends in European Forestry (the course is part of the ERASMUS MUNDUS European Forestry Master's Program)

More information:
Education at SRH, www.slu.se/en/srh/education.

Text, Figure and Table:
Erik Wilhelmssom, SLU.

Master's Theses

Forest Inventory

Isaksson, Bengt. 2013. Relascope sampling for crown ratio estimation: Method optimization and measurement error study. (Supervisor: Göran Ståhl)

Lindgren, Jenny. 2013. Sale of Sveaskog's forestland in Vilhelmina and Dorotea: Aims and outcomes from a rural perspective. (Supervisor: Gun Lidestav)

Forest Planning

Norberg, Jessica. 2013. Characteristics of timber harvest and fertilization areas: Analyzing present and future states of planned tracts at the district of Umeå, Holmen Skog. (Supervisor: Hampus Holmström)

Färnstrand, Björn. 2013. Stand prioritization by spatial aggregation to forest management tracts. (Supervisor: Ola Eriksson)

Forest Operations Management

Nilsson, Göran. 2013. Effects of grapple-tilt on forwarder productivity. (Supervisor: Dan Bergström)

Asmoarp, Victor. 2013. Terminal strategies for wood chips at Södra Skogsenergi. (Supervisor: Dimitris Athanassiadis)

Zilo, Torbjörn. 2013. Reducing transportation lead-times for deciduous saw logs and firewood logs by co-transportation with other assortments. (Supervisor: Dag Fjeld)

Narfström, Karl. 2013. Optimizing forest residue chips flows with the decision support BioMax. (Supervisor: Dag Fjeld)

Öhman, Emil. 2013. The wheel forwarders technical development. (Supervisor: Tomas Nordfjell)

Johansson, Carl. 2013. Multi-tree handling in final-felling. (Supervisor: Dan Bergström)

Wittenström, Anders. 2013. Geographical flows of wood fuels for the county of Jämtland. (Supervisor: Dimitris Athanassiadis)

Arvid Lindman's Award 2013

Håkan Johansson was awarded for his Master's thesis entitled "Tactical planning with geographic consideration - Case study with Heureka PlanWise at SCA Forest district Liden". (Supervisor: Peder Wikström)

Figure 1. The new Heureka course "PlanWise as Decision Support in Forestry Planning" had 57 students from SLU's Master of Forestry Program.

More information:
The Master's Theses can be found in SLU's digital archive Epsilon, http://epsilon.slu.se.

Text: Ylva Jonsson, SLU.
Figure: Mona Bonta Bergman, SLU.

Doctoral Studies

Hans Petersson
Vice Head and Director
Doctoral Studies

The PhD program aims to provide a high-quality university education, where PhD students gain both broad knowledge and expert skills in the competence area of their choice.

In 2013, a total of 22 active students were enrolled, including 11 men and 11 women. Three PhD students completed their studies resulting in two doctoral degrees and one licentiate degree, and two new students were recruited. A total of 2, 8, 5, 5 and 2 students passed 0%, 25%, 50%, 75% and 100% of their examinations, respectively.

The PhD students made great progress, and their research resulted in co-authorships in several scientific publications. In addition, the PhDs who completed their doctoral studies the previous year published several manuscripts from their theses. PhD students also presented their results at several national and international conferences, meetings and workshops.

The majority of the PhD students actively participated in seminars, and many of them participated in a PhD student day organized by the Department. Representative students have taken part in the Working Committee of Doctoral Studies at the Department and the self-organized Council of Doctoral Students.

Currently, 10 different senior researchers act as supervisors, and the PhD students are supported by about 31 assistant supervisors. The gender balance within the group is uneven with only three female supervisors and seven female assistant supervisors.

The Department undertakes an annual review of the individual study plans of all PhD students, and the Department's Director of Doctoral Studies reports the outcome of this review to the Faculty. The Director of Doctoral Studies at the Faculty organizes annual meetings for the department directors to provide information about new regulations and to facilitate harmonization of the various PhD studies.

In 2013, the Department offered the following scheduled courses at the PhD level: Forest Governance on a Landscape Scale – Northern European Perspective (7.5 ECTS, 8 participants) and Basic Sampling Theory with Applications (4 ECTS, 10 participants).

After reorganisation, 10 of our PhD students moved to the Department of Forest Biomaterials and Technology; we wish them good luck in their future careers!

More information:
Education at SRH,
www.slu.se/en/srh/
education.

Text: Hans Petersson, SLU.
Figure: Viktor Wrange, SLU.

Doctoral Theses

Doctorate – Forest Planning

Malin Nilsson
Knowledge in the forest planning process

Dissertation: May
Supervisor: Professor Ola Eriksson
Assistant supervisor: University lecturer Dianne Staal Wästerlund and Dr Olof Wahlberg

Doctorate – Forest Planning

Anu Korosuo
Spatial problems in long-term forest planning:
From preferences to plans

Dissertation: May
Supervisor: Professor Ola Eriksson
Assistant supervisor: Associate professor Karin Öhman

Licentiate – Forest in Rural Studies

Mersha Gebrehiwot
Recent transitions in Ethiopian homegarden agroforestry: Driving forces and changing gender relations

Dissertation: June
Supervisor: Associate professor Gun Lidestav
Assistant supervisor: Associate professor Marine Elbakidze and Dr Mats Sandewall

More information:
The Doctoral Theses can be found in SLU's digital archive Epsilon, http://epsilon.slu.se.

Text: Ylva Jonsson, SLU.
Figures: Patrik Umaerus, SLU and Elias Andersson, SLU.

Remote Sensing

Håkan Olsson
Competence Area
Manager

Staff
Peder Axensten
Mikael Egberth
Johan Fransson
Johan Holmgren
Mats Högström
Jonas Jonzén
Eva Lindberg
Nils Lindgren
Mats Nilsson
Karin Nordkvist
Kenneth Olofsson
Heather Reese
Emma Sandström
Jörgen Wallerman

Doctoral Students
Jonas Bohlin
Mona Forsman
Ann-Helen Granholm
Mattias Nyström
Henrik Persson

Landscape visualizations of forest development

Due to our competence in Remote Sensing and GIS, the Section of Forest Remote Sensing has been asked many times if we can construct computerised landscape visualizations. The answer is Yes, we can! The power of landscape visualization is that we can accurately illustrate alternative landscape developments. Forecasting of forest development over time can be performed, for example, with the Heureka software system.

After some testing and development, we are now using the Visual Nature Studio III software package. The first step in a visualization project is to create a digital terrain model, that often consists of the 2-meter grid digital elevation model from the national land survey. Second, the ground must be assigned textures depending on the land cover class. The textures are a combination of photographs of the ground from UAVs (unmanned aerial vehicles) and 2-dimensional plant models. The third step is to place trees in the digital landscape and to set parameters such as height, species, and number of stems per unit area. Since we are a forest research group, we would like our trees to have their canopy shaped realistically for trees growing in the forest. There are existing tree libraries with digital trees, but they often contain tree models with large canopies and crooked trunks. Therefore, we had to make our own tree library. The trees in the library have been modelled with the XFROG software based on photographs from a field survey of Swedish forests. Once the digital landscape is created, it is possible to render images from arbitrary camera views or to create short movies from a set of images.

The tree library contains photographs from the field survey and visualized trees in two dimensions. The contents of the database are free of charge, you find more information about this at the webpage.

Figures 1 and 2 are from the Formas financed Smart Tree Retention program and show the forecasted development of a forest landscape in Västerbotten (Strömsjöliden). These examples are based on present forestry practice with 5% retention level.

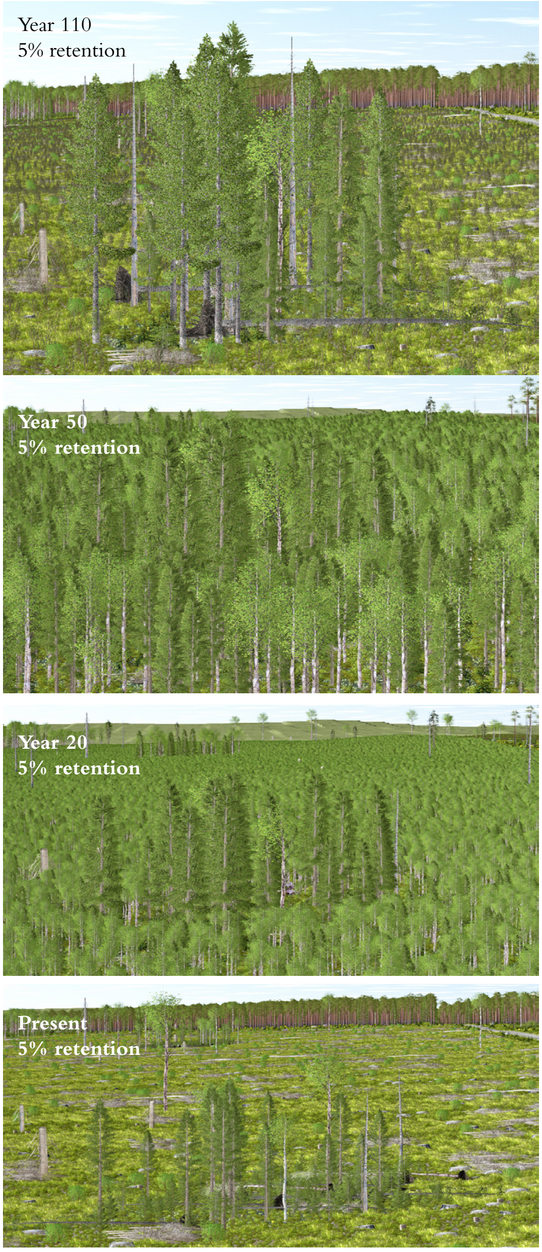


Figure 1. Close up of a retention patch with forecast from present to year 110, 5% retention level.

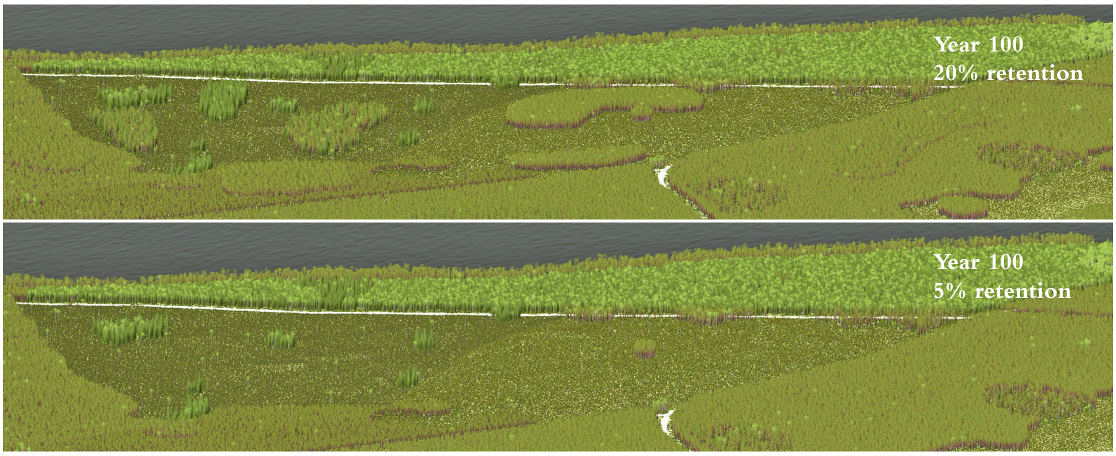


Figure 2. Landscape view from year 100 with 5% retention level and with 20% retention level.

More information: Landscape visualization, images and tree library at www.slu.se/landscapevisualization.

Text:
Håkan Olsson, SLU and
Emma Sandström, SLU.
Figures:
Emma Sandström, SLU.

Forest Inventory and Empirical Ecosystem Modeling

LULUCF - Reporting greenhouse gases under the Kyoto Protocol

The principal objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to "stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". In this context, forests and forest soils represent two principal sources of terrestrial carbon sequestration. Harvested wood products (HWP) have a value both as a form of carbon sequestration and as a fossil fuel substitute, and biomass for heat and power generation is an important source of renewable energy.

Soon after celebrating the new millennium, the Department became involved in preparing a method for reporting emissions and removals of GHG in the Land Use, Land-Use Change and Forestry sector (LULUCF) and was responsible for the actual UNFCCC reporting. Within this framework, the aim was to establish and to gradually improve a system for monitoring changes in terrestrial carbon pools in Sweden. Changes in carbon pools are estimated using area-based sampling with data from the Swedish National Forest Inventory (NFI) and the Swedish Forest Soil Inventory (Department of Soil and Environment). The Heureka simulation model has been used (Anders Lundström) to follow-up and to develop a reference for accounting (the Forest Management Reference Level). The project also includes policy discussions about how an alternative accounting model might be used to stimulate improvements. To discuss this issue, the Department has organized side events at COP15 in Copenhagen 2009, COP16 in Cancun 2010, COP17 in Durban 2011, COP18 in Qatar 2012 and COP19 in Warsaw 2013 (Dr David Ellison, Dr Mattias Lundblad and Dr Hans Petersson), (Figure 1).

Figure 1. The side-event panel "LULUCF & REDD+ Convergence and the International Climate Policy Framework" at COP19, 18 November, 2013 in Warsaw.

The project was initiated by Professor Göran Ståhl. The most important carbon pools reported are HWP (Dr Per-Erik Wikberg), above-ground and below-ground living biomass (Dr Hans Petersson), deadwood including stumps and litter (Dr Hans Petersson and Dr Ylva Melin), and soil organic carbon (Dr Mattias Lundblad and Dr Erik Karltun). Under the UNFCCC, changes in carbon pools are matched to land use and land-use change and traced back to 1990, while under the Kyoto Protocol carbon pools are matched to activities. David Alger and Karl-Erik Grundberg have written the code to transform data from the NFI to the format requested in the guidelines provided by the Intergovernmental Panel on Climate Change and in decisions made by the Conference of Parties under the UNFCCC (Figure 2).

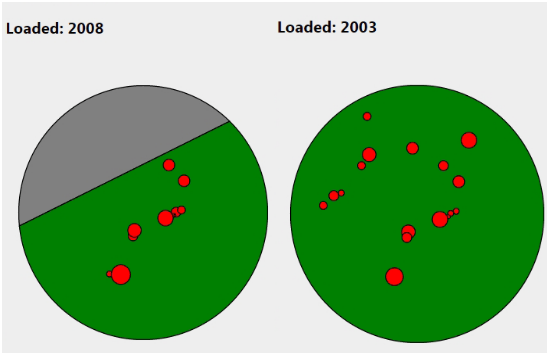


Figure 2. The "GreenbaseWeb" application makes it possible to study individual sample plots that have been re-inventoried in different cycles. This specific sample plot was partly deforested between 2003 and 2008. The positions of trees and sample plots were sometimes divided into more than one land-use category, and this makes it possible to separate emissions/removals into activities (here Deforestation and Forest Management) and land-use categories (here Settlements (road) and Forestland). Thus, emissions/removals can be matched to activities/land use and can be traced back to the beginning of the first commitment period (1990). The "GreenbaseWeb" was developed by David Alger and Karl-Erik Grundberg.

The next step is to adapt to new guidelines for the second commitment period of the Kyoto Protocol (2013–2020). In addition, the European parliament and council have decided on accounting rules and action plans for GHG emissions and removals resulting from activities related to LULUCF (COM(2012) 93 final). Reports under both of these commitments will be submitted for the first time in 2015. Future challenges may include the reporting of Natural Disturbances, Cropland Management and Grazing Land Management.

Göran Ståhl
Competence Area Manager

Staff
Anna-Lena Axelsson
Henrik Feychting
Anna Hedström Ringvall
Torgny Lind
Kenneth Nyström
Hans Petersson
Martin Vestman

Doctoral Students
Sarah Ehlers
Ylva Melin
Cornelia Roberge
Sebastian Schnell
Nicole Suty

Guest Researcher
Habibollah Ramezani
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Forest Planning

Evaluating continuous cover forestry based on the forest owner's objectives by combining scenario analysis and multiple-criteria decision analysis

There are many claims on the Swedish forest. Maybe it is as Birk Borkason says in Astrid Lindgren's book "Ronja Rövardotter" that it is not my forest or your forest, but the forest belongs to everyone, even the foxes, the buzzards and the owls. A landowner who this is particularly true for is the municipality. The municipality has many times an extra responsibility of accounting for the interests of all municipal residents. The maximization of income from forestry is seldom the only objective for municipal forest management, and forests are often managed so that ecological and social values are promoted equally or with even more importance. To cope with these conflicting objectives, the landowner must make trade-offs. A possible approach in such situations is to use quantitative forest scenario analysis and multiple-criteria decision analysis (MCDA) methods. The scenario analysis can be used to determine the effects of different types of forest management on the economic, ecological, and social values of the forest. In turn, MCDA can clarify how important different objectives are and can evaluate the impact of these trade-offs on the different objectives.

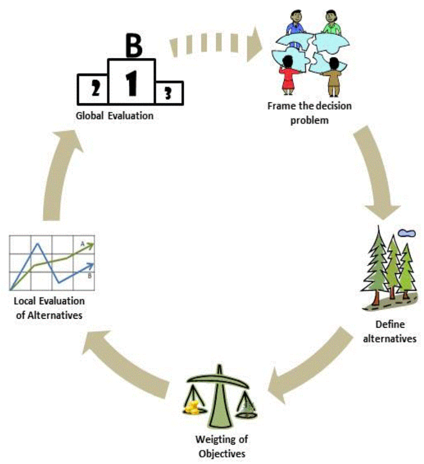

Figure 1. The general five-step planning process that was used in the case study of Linköping. The dashed line indicates that in some cases the process has to be iterated if no acceptable alternative is found.

The combination of these two tools, forest scenario analysis and MCDA, was tested in a case study in Linköping in 2013 by Karin Öhman, Eva-Maria Nordström and Hampus Holmström. The municipality was interested in finding out if continuous cover forestry (CCF) was a better option than even-aged forestry for their urban forests. In even-aged forestry, the forest is divided into stands and a cycle of final felling, regeneration, and thinning is performed over the course of each rotation period to produce a relatively homogeneous forest structure within each stand with respect to tree age, height and diameter. CCF, in contrast, is characterized by selective harvesting without the creation of large clear-cut areas. The stand age is undefined, and forest development does not follow a cyclical harvest-and-regeneration pattern. Because various management systems will have different outcomes with respect to each of the objectives considered, the question of which system is best should be answered by considering not only how the management affects the objectives for the forest but also the relative importance of these objectives to the municipality. The first step in the combined decision process was to decide upon the objectives for the forest management together with representatives for the municipality. These objectives were arranged in an objective hierarchy that described how the objectives related to each other. Three alternative scenarios were then created using the Heureka system. The scenarios described the forest development and the outcome for the objectives for 100 years under the following three different management approaches: (a) even-aged forestry, (b) CCF and (c) a combination of even-aged forestry and CCF. The representatives for the municipality then used the MCDA application in Heureka to assess the importance of the various objectives in relation to each other and how well each scenario met the different objectives.

The quantitative scenario analysis showed that in the case of Linköping, CCF was a good management strategy in terms of ecological and social objectives, but results in worse economic outcomes than conventional even-aged forestry. However, the MCDA showed that in this case there was a relatively

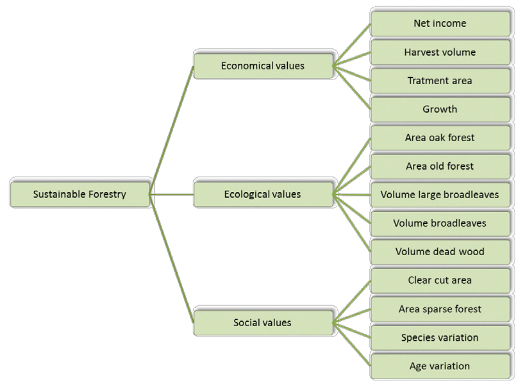

Figure 2. Objective hierarchy for the case study stated by representatives for the municipality alongside the statements in the municipality's general forest policy.

strong emphasis on ecological and social aspects in the municipality and thus CCF seemed to be the most suitable option.

The case of Linköping municipality shows that a combination of scenario analysis and MCDA is very useful for strategic decision-making and for combining subjective and objective modelling. However, it is important to remember that it is a decision support method. That is to say, its purpose is not primarily to produce the best solution or even the "truth", but rather to provide a more detailed understanding of the problem at hand.

Through the process, the decision-makers learn more about the possibilities and limitations of various alternatives and about the trade-offs between different objectives. This increases their ability to make informed decisions and to identify policies that are likely to achieve their overall objectives.

Forest in Rural Studies

Recent transitions in Ethiopian homegarden agroforestry: Driving forces and changing gender relations

The academic area of Forest in Rural Studies is concerned with human-induced change processes and their influence on rural communities, households and individuals both in a global North and a global South context. Founded on a long-term collaboration with Wondo Genet College of Forestry and Natural Resources in Ethiopia, a licentiate project was carried out from November 2010 to June 2013 that focused on the transition from homegarden agroforestry to cash crop production and the impact this transition has had on gender relations.

Homegarden agroforestry in Ethiopia originate from the use of natural forests, and its components and structure have evolved over time to meet the socio-economic and cultural needs of the rural community. It is known for its diversity, ecosystem balance and sustainability while contributing to people's livelihoods in the region, but it has recently been challenged by population pressure, shrinking farm size, poverty and a new market situation. The land use has, thus, gradually changed towards monoculture production of khat (Catha edulis) and eucalyptus species. The change from subsistence to market-oriented production has resulted in structural and functional changes that have reduced the multiple functionality of the homegarden. These changes have resulted in short-term improvement in financial income, but at the same time they have led to a decline in subsistence production of food, increased instability and reduced social equitability in rural households.

Figure 1. A traditional homegarden in Ethiopia.

During the project, Mersha Gebrehiwot of Wondo Genet College of Forestry and her supervisors Gun Lidestav and Mats Sandewall of the Department of Forest Resource Management, Marine Elbakidze of the School of Forest Management, SLU, and Habtemariam Kassa of CIFOR have conducted a number of surveys to increase the understanding of the drivers and consequences of these on-going land-use changes. The long-term goal of the project was to contribute to institutional development efforts towards stable and sustainable landuse and gender equity in rural development. The specific objectives were 1) to assess the on-going trend of change from traditional homegarden agroforestry towards cash crop production and its proximate and underlying causes and 2) to analyse and explain how the land-use change affects the lives of farm women and men, gender roles, gender power relationships, and space for action and agency. Interviews, relevant literature, documents, files and records were used as the data sources for understanding the drivers and potential consequences of the change.

Figure 2. A farm woman processing enset for household consumption.

The studies confirmed a trend towards increasing cash crops and decreasing perennial and annual crops. The main proximate causes of change identified by the respondents are; financial income, farmland fragmentation, favourable market conditions for new cash crops, access to irrigation, limited supply of farm input for food crop production, experience of others, risk of theft, and wildlife disturbance. They were in turn underpinned by underlying factors such as demographic, economic, policy/institutional, socio-cultural and technological forces. The analysis of the system dynamics shows that all underlying driving forces interact with each other and cause change in traditional practices, although policy and institutional factors could be seen as key drivers provoking changes in other driving forces. The change in landuse has significantly affected household food supply, local markets and the financial income from cash crop trading. It has also affected household division of labour, decision-making, family sharing and distribution of income, gender roles for women, and men and household gender power relationships. The expansion of cash crops has enhanced the decision-making and bargaining power of men because most production and trading of cash crops and income is controlled by men. At the same time, women's traditional role has been declining in terms of labour input, access and control over products, decision-making, and bargaining over the use and distribution of resources.

The transition has affected the rationale for weighing and balancing the economic, socio-cultural, and ecological benefits derived from traditional homegarden agroforestry in the study region. Therefore, securing gender equality and balancing the economic benefits with the socio-cultural and ecological values of this system should be considered in regional agricultural development plans and land-use policies that seek to implement sustainable rural development.

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Forecasting as a tool in forest policy and decision-making in Vietnam

Between 1990 and 2010, Vietnam increased its forest cover by 6.5% annually, which was faster than most other countries in the world (Figure 1). This change was driven by political reforms combined with globalizing markets and other changes. For society, this development has meant new opportunities but also challenges, and it has had significant impacts on people's livelihoods, the economy, the environment and the climate.

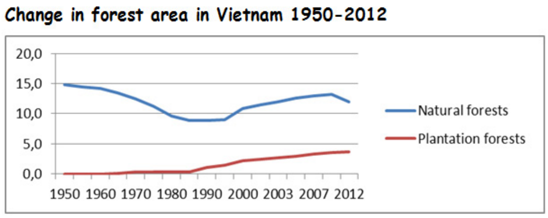

Figure 1. Trends in Vietnam's forest cover (in million hectares) since 1950.

This project sought to develop a forecasting approach to support policy and decision-making for sustainable forestland management and to increase the forecasting capacity of Vietnam's forest sector. The project was implemented as a "partner driven cooperation" from August 2012 until December 2013 among the Forest Inventory and Planning Institute (FIPI) in Vietnam, the Swedish University of Agricultural Sciences (Mats Sandewall, Ulf Söderberg and Esbjörn Andersson), and the Swedish Forest Agency (Björn Merkell). Initial funds were granted by Sida, and additional resource inputs were provided by the partner organizations.

The project approach included database development, staff training (Figure 2), testing of data collection methods and a forecast scenario model in a district-level case study, elaboration of optional scenarios, and discussion of outcomes with stakeholders. The final report was presented at a national seminar where the outcomes, relevance, and further development needs were discussed.

Figure 2. Training course in Sweden for key project staff.

The applied scenario tool, the Area Production Model, is designed as a tool for use in forest policy and strategic management planning. It enables generalized simulations of future land-use changes (scenarios) based on data on current land use and trends and assumptions about demographic changes, economic growth, and changes in agricultural and forest production (Figure 3). The scenario can be run for defined landscapes (e.g. districts) over a period of 5 to 50 years. A principle assumption in the current version of the model is that the amount of land needed for agriculture at any given time will be used for that purpose and areas not needed for agriculture will be used for forestry. In order to make it more user friendly and reflect the current strategic issues in forestry, FIPI and SLU updated and adapted some parts of the Area Production Model in an Excel-based version. Further development of the

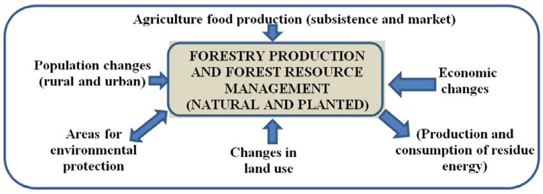

Figure 3. Some principle issues being addressed in the Area Production Model.

system will depend on the needs and priorities identified by the system users as well as their experiences with the system.

Scenario analysis: The impact of future policies and management programs can be studied by elaborating on and comparing alternative scenarios. In the district study, landscape-level data on land use trends, forestry and socio-economic situation were collected using qualitative and quantitative methods. Scenarios based on those data were discussed with farmers and decision-makers.

The strategic concern in Vietnam's forest sector (and in most other countries) is how to implement sustainable management of natural forests and plantations that can balance the needs of economic production, food security, bio-diversity protection and climate change mitigation. Forest cover increased rapidly in the study area as a result of plantation policies, but this was mainly through monoculture plantations (Figure 4) and there were concerns about biodiversity and economic sustainability.

Figure 4. Farmers mostly produced short-rotation acacia on their land.

We concluded that even though the tested scenario model includes simplified assumptions it is relatively transparent and it allows the users to discuss strategic issues and to further adapt the model to more specific needs. It also provides users with a tool to address long-term issues with impacts in the future that require steps to be taken now (e.g. addressing climate change through natural resource management).

More information:
International Forestry,
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Text and Figures:
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Environmental Monitoring and Assessment

The place of monitoring in environmental science

The Department of Forest Resource Management is one of the hubs for environmental monitoring and monitoring-based analyses at SLU. The Swedish National Forest Inventory (NFI), National Inventory of Landscapes in Sweden (NILS), Terrestrial Habitat Monitoring (THUF), Forest Sustainability Analysis (SHa), and other activities provide a wealth of knowledge and experiences as well as an extensive source of environmental data. With a growing pool of applied research projects and implementation actions associated with the monitoring programs that bridge the gap to the sector and to the stakeholders, monitoring and monitoring-based analyses and applications are positioned in environmental science.

Environmental monitoring is about providing time series of consistent measurements of variables where the monitoring protocol is designed to answer questions about environmental conditions and changes and where there is an identified output and/or outcome stakeholder. A general assumption is that longer-term monitoring programs provide more valuable data. Many ecosystems require long-term study because the ecological processes take a long time or because multiple factors and feedback mechanisms are involved. Long-term monitoring data also provide a context for short-term experiments and observations, add a more comprehensive perspective for management systems, and can be used for evaluating ecosystem responses to disturbances and climate change as well as to design adaptation or mitigation strategies.

Scientists need monitoring as part of integrated environmental research programs. Policy-makers need monitoring to design, implement, and evaluate environmental policies. Land-use strategists and planners need monitoring to achieve sustainable landuse and management objectives. The public need monitoring to keep track of how the politicians and the primary land-use actors are using our forest and other natural resources.

It has been questioned whether monitoring has a place in environmental science. Common criticisms are, for example, that monitoring is simply acquiring data for the sake of acquiring data, that most data are never used, or that monitoring responds to the information needs of the past rather than to current needs or expected needs in the future. A contrasting view, however, is that a monitoring approach driven by tractable and up-to-date societal questions, has a statistical and methodological design and matches the nature of the entities being examined becomes a critical part of the infrastructure of environmental science.

In 2013 we witnessed an increasing demand for adjustments, improvements and novel expansions in the Department's activities. The Department's monitoring and monitoring-based analyses are under constant development, with new monitoring stakeholders appearing and new types of data demand needed. This calls for a need of flexibility and capacity to add new variables and inventories on top of the core, long-term monitoring protocol. In a societal context, it is also obvious that the use of monitoring data has become more diversified, e.g., as baseline information for policy and governance, for strategic scenario/impact analyses of landuse and for large-scale landscape planning modules. This development also implies a need for effective and immediate cause-and-effect analyses and, accordingly, close co-operation with the research community.

There is also a need to develop monitoring systems that are multi-national and allow harmonization of existing environmental monitoring protocols, analyses and reporting procedures, but that also have an inherent capacity to comply with national and local policy goals. This requires monitoring systems that are based on an understanding of ecosystem processes on appropriate scales, that encompass features that are possible to monitor with adequate accuracy given the available techniques, and that relate to policy and decision-making in a societal context. In a wider context, it is also necessary to integrate biophysical landscape data with socio-economic data to provide holistic, socio-ecological background information for sustainable land use and management on strategic and operational levels. Moreover, monitoring needs to have an inherent capacity to adjust to societal needs and, if demanded, to include new or supplementary variables, albeit with long-term robustness in the core data and monitoring methods to allow for consistency in analysis and reporting schemes.

The societal need for continued development of monitoring and monitoring-based analyses justifies the place in environmental science.

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Figure: NILS field staff, SLU.

National Forest Inventory

Effects of different standards for forest age and tree species composition

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The Swedish National Forest Inventory (NFI) is a sample inventory designed to provide information to help answer questions regarding forests and land use in Sweden. It is important, therefore, that the methods and standards employed by the Swedish NFI with regard to both fieldwork and data processing have a sound scientific basis and are well accepted. It is also essential that definitions used in data processing are clearly formulated and explained.

Forest age provides a good example of how large differences can occur depending on the method of calculation. The use of arithmetic mean age results in a considerably lower average stand age than if a basal-area-weighted average age is used (Figure 1).

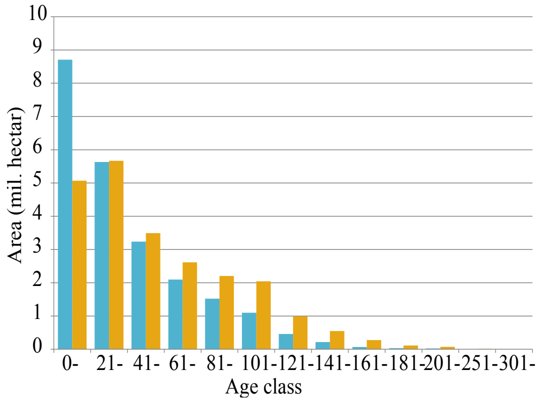

Figure 1. Area of productive forestland (2008–2012) by age class based on arithmetic mean age (blue) and basal-area-weighted mean age (orange).

Another critical factor when calculating the age of a forest stand is which trees are included in the calculation. The Swedish NFI does not include standards, seed trees or understorey trees when defining stand age (Figures 2 and 3). However, other methods of defining forest age might include these trees, for example, if the methods include all trees over a stated age. A further example, using tree species composition, is the importance of defining the threshold for stand types. If the cut-off for a specific stand type is moved from requiring ≥65% of the trees to be of the same species or species group to ≥95%, then the area classified as monoculture forests in Sweden would be drastically reduced and the area classified as mixed forests would increase (Figure 4).

Figure 2. Older pine forest with an understorey of smaller spruce.

Figure 3. On the sample plot.

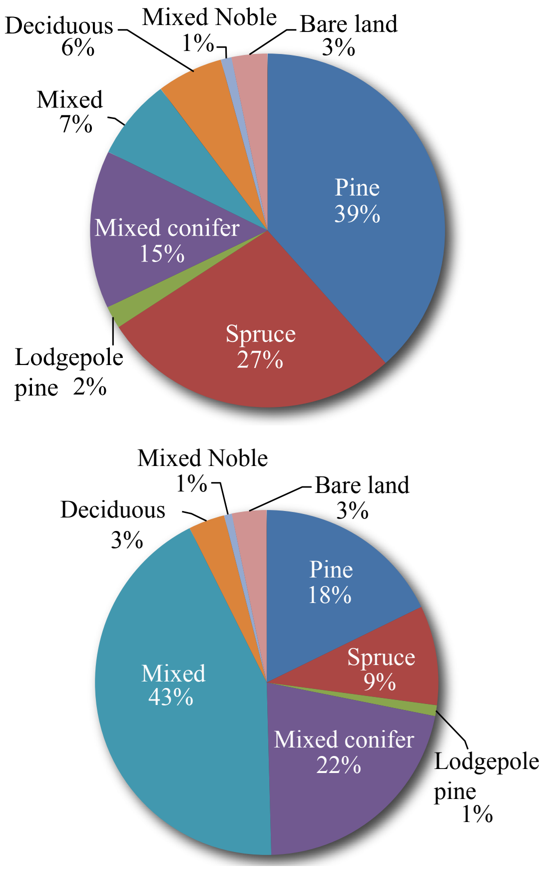

Figure 4. Productive forest area by stand type. Definitions according to SKOGSDATA. The threshold for monoculture is ≥65% (top) or ≥95% (bottom).

More information:
Other aspects of the Swedish National Forest Invetory are available at www.slu.se/foreststatistics.

Text: Göran Kempe, SLU and Jonas Fridman, SLU. Figures: Neil Cory, SLU, Per Nilsson, SLU and Åke Bruhn, SLU.

National Inventory of Landscapes in Sweden

Evaluation of NILS data in the mountains

The national monitoring program National Inventory of Landscapes in Sweden (NILS) was designed to monitor the prerequisites for biodiversity at a national level and to contribute to the follow-up of the Swedish Environmental Objectives. Currently, there is also an increasing interest in evaluating the extent to which data sampled in NILS can be used to monitor the distribution and status of various habitats on a regional scale. This mountain project started in 2013 in collaboration with the County Administrative Boards of Norrbotten, Västerbotten, Jämtland and Dalarna. The main objective is to evaluate which NILS variables are appropriate to include in mountain regional monitoring, i.e. the northern mountain range including Norrbotten, and the southern mountain range including Västerbotten, Jämtland and Dalarna.

Over the past decades there has been an increasing awareness of how changes in climate and land use might affect the distribution and status of mountain habitats in Sweden. Models predict that the extent of mountain birch forest in Fennoscandia may increase with climate warming and, thus, substantially reduce the extent of alpine heaths. Indeed, small-scale studies have revealed that the tree line is generally advancing higher up along the mountain slopes and that the mountain birch forest is becoming denser. Warming experiments also indicate an increased biomass of graminoids and dwarf-shrubs, while slow-growing alpine and arctic species might decrease. However, it is difficult to say if these change phenomena are applicable to the whole mountain range or only to certain places or areas. Unfortunately, there are few environmental and biological monitoring programs in the mountain range that are both long-term and large-scale. The few that exist, such as that of the former Swedish Environmental Program, are usually limited by few replicates and geographical bias. NILS is the only large-scale environmental monitoring program that can reveal changes in vegetation across the entire mountain range.

The results to date suggest that NILS can deliver data for national and regional environmental monitoring and can provide indicators for use in following up of the environmental objective "A Magnificent Mountain Landscape". Our results show that there have not been any significant changes in the extent of alpine area or mountain birch forest from the years 2003–2007 to the years 2008–2012. However, the total canopy cover in the mountains has increased across the entire mountain range over the same time period. Similarly, the cover of field layer species has increased across the entire mountain region, especially graminoids and dwarf-shrubs. We can also show that there has been an increasing number of vehicle trails throughout the mountains. We conclude that in order to follow the distribution and status of a certain variable with sufficient accuracy, that variable needs to occur in at least 13 sample squares. Consequently, there is a need to increase the sample density in order to be able to monitor the less common variables.

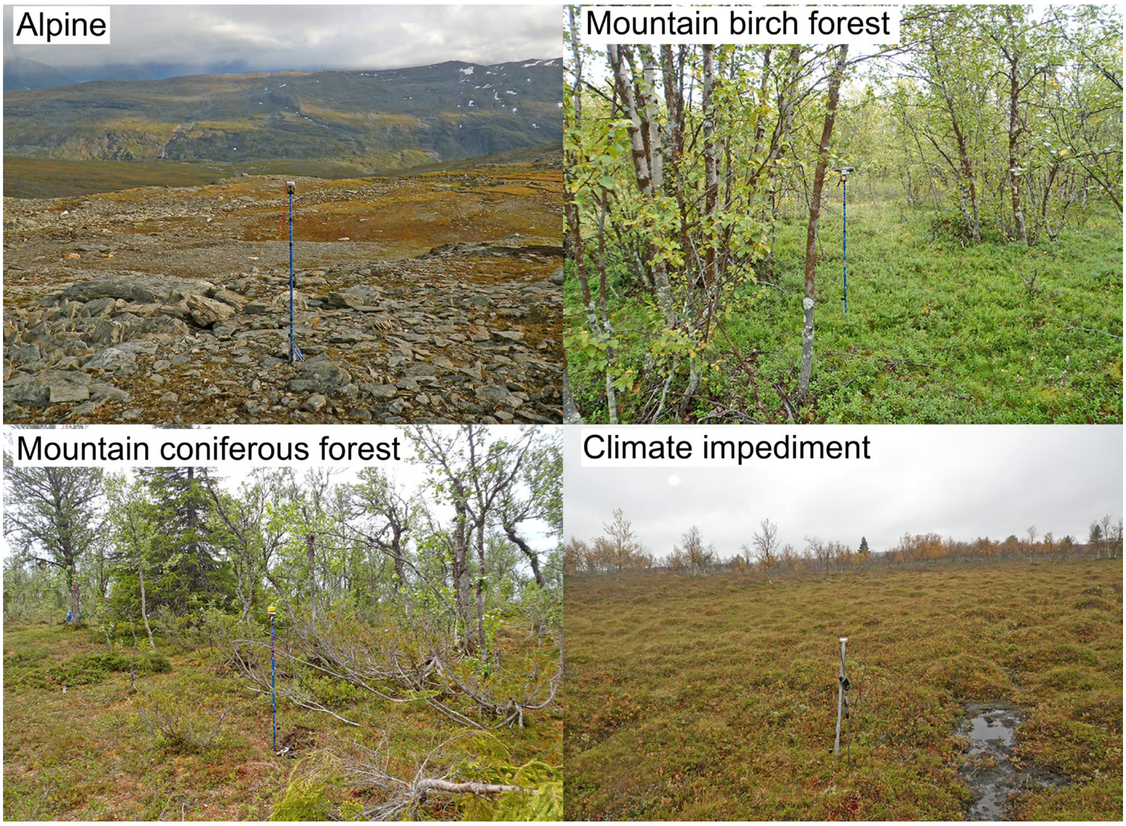

Figure 1. Four mountain habitats.

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The program also uses other employees within the Department's competence areas and environmental monitoring programs.

More information:
National Inventory of Landscapes in Sweden, www.slu.se/nils.

Text: Henrik Hedenås, SLU.
Figures: NILS field staff, SLU.

Terrestrial Habitat Monitoring

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The EU Habitats Directive can be seen as the foundation of the European Union's nature conservation policy. The aim of the directive is to protect habitats and species of European community interest, and it states that every member state shall undertake surveillance of the conservation status of habitats and species. As a response, the program Terrestrial Habitat Monitoring (THUF) was initiated in 2006 with the aim to develop efficient methods for monitoring and assessment of terrestrial habitats of high conservation status and later also organizing necessary data collection, analysis and reporting.

The Swedish National Forest Inventory (NFI) and National Inventory of Landscapes in Sweden (NILS) are two on-going programs at the Department that already collects data on coverage and status of terrestrial habitats. In 2008, additional habitat variables were included in these programs and assessment shows that the Swedish NFI and NILS are both able to deliver accurate habitat information on common habitats. However, for less abundant habitat types the precision is too low to fulfil the reporting requirements.

Monitoring of Terrestrial Habitats (Life+ MOTH) is a collaborative project between SLU and the Swedish Environmental Protection Agency. The objective of the project is to develop and demonstrate a fully functional monitoring program including all necessary steps; sampling design, data collection, data management, analysis and reporting. The project develops two novel habitat surveys targeting sparse habitats based on two-phase sampling methodology. The project also develops and testes methods for combining estimates from several data sources.

The general habitat inventory covers all regions in Sweden. The sampling unit is a landscape plot with a size of 5.0 km × 2.2 km. In each plot, a regular grid of 200 points is surveyed. The process starts with manual interpretation and classification of all grid-points with photogrammetric methods using digital infrared aerial images. The grid points are grouped into general habitat categories using a habitat classification protocol based on the baseline survey of Natura 2000 sites. From each habitat group, we randomly selected points to be included in a set of field points. These are visited in the field, and a number of variables are recorded, including habitat, land use, vegetation, and other variables that can be used for determining the conservation status of the plot. The field assessment is conducted in collaboration with the NILS program. In September 2013, the last season of data collection was finished within the EU project. A total of 566 plots distributed all over Sweden with a total of 110,814 grid points have been surveyed manually by remote sensing. A random selection of 5976 of these plots were later visited and surveyed by our field teams.

The seashore habitat inventory is focused on the terrestrial parts of the Swedish marine shores. The survey was based on 250 sample units (5.0 km × 2.5 km) randomly placed along the Swedish marine coastline. A hexagonal grid was placed over an aerial photograph of each sample unit, and a photo interpreter scrutinized every intersection between the grid and shoreline and makes a rough classification of the habitat based on substrate, vegetation, degree of exploitation, etc. Points likely to represent interesting habitat types are later randomly selected for field surveys. At each selected point, field workers placed a 10 m wide transect across the shore. Habitats are classified, and variables such as land use, plant species and marine debris were noted. When the data from all points are compiled, the total area of shore habitats can be calculated and their overall conservation status can be assessed. The project has finished two years of data collection in September 2013. In total 100 sampling units with a total of 6888 shore transects were surveyed using remote sensing. Of these, 566 were randomly selected and surveyed in the field.

MOTH is a Life+ project financed by the European Commission, the Swedish Environmental Protection Agency and SLU. The full name of the project is "Demonstration of an integrated North-European system for monitoring terrestrial habitats", and the project code is LIFE08 NAT/S/000264. The project started in January 2010 and will end in December 2014. The total budget is 4.8 million Euro.

External collaborators: Gudrun Norstedt, Henrik Weibull, Johan Abenius and Conny Jacobson.

More information:
Monitoring of Terrestrial Habitats, www.slu.se/moth.

Text: Hans Gardfjell, SLU.
Figure: NILS field staff, SLU.

Forest Sustainability Analysis

The Department runs a number of monitoring programs of forests and landscapes. Equally important, though, is the analysis of the future developments of these resources based on different scenarios. The Forest Sustainability Analysis (SHa) program at the Department is a significant complement to the environmental monitoring programs. The aim of SHa is to provide competence, decision support tools, and analyses related to forest resource development and its production of ecosystem services to policy developers, decision-makers and managers within sectors such as forestry, environment protection and energy. The newly developed Heureka system is a central technical platform for the SHa's activities. The Heureka system includes a number of software programs for analysis and planning of multi-objective forestry. The system is widely used in research, teaching and practical forestry, and SHa is responsible for its maintenance and further development. In 2013, twelve stakeholders agreed on joint responsibility for financing the maintenance of the system, and this is a significant step in securing the long-term accessibility and functionality of the system.

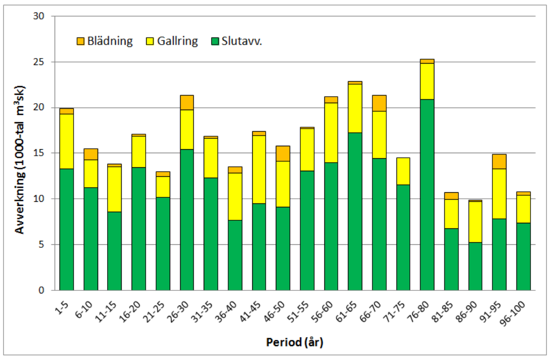

Figure 1. The analyses of all scenarios were performed with Heureka PlanWise by adapting the simulated forestry with different objectives and different treatment proposals, reporting results like, e.g., a long-term harvest plan.

Strategic planning in practical forestry. SHa initiates research and development projects and takes part in projects initiated by others. One of the SHa-associated projects in 2013 was Strategic Planning in Practical Forestry, which was financed by the Petersson-Grebbe Foundation in south-western Sweden and sought to demonstrate the effects of different forestry objectives on the 480 hectares of forest land on the Fänneslunda forest estate. Goal-oriented forest management will have both short-term and long-term effects on both the state of the forest and the forestry. Temporal and spatial analyses of the forest data led to harvesting plans at the stand level that were based on the objectives of the scenarios. Three different scenarios were defined in co-operation with the Board of the Petersson-Grebbe Foundation. The first scenario was conventional even-aged forestry, the second scenario sought to maximize the net cash flow through growth-enhancing measures such as fertilization, and the third scenario represented forestry favouring recreational and outdoor values by using different types of uneven-aged forest management systems. The results at the level of the forest estate showed only modest differences between the three scenarios. For example, the average harvest level for the 100-year planning horizon was 7 m^3 ha^{-1} $year^{-1}$ for the first scenario, 8 m^3 ha^{-1} $year^{-1}$ for the second scenario and 5 m^3 ha^{-1} $year^{-1}$ for the third scenario. Perhaps the most significant impact on the future forest management is past forest management. However, greater differences could be seen when considering the results of the different scenarios at stand level of harvest treatment proposals. This more detailed analysis showed significant differences between the scenarios when specific stands are treated in a specific way at a specific time depending on the objectives of the scenarios.

The project was carried out by Hampus Holmström in 2013, and the results have been presented in a Department work report (number 410 2014, available only in Swedish). A meeting with the Board of the Petersson-Grebbe Foundation and stakeholders will take place, in the area surrounding Fänneslunda, in the summer of 2014.

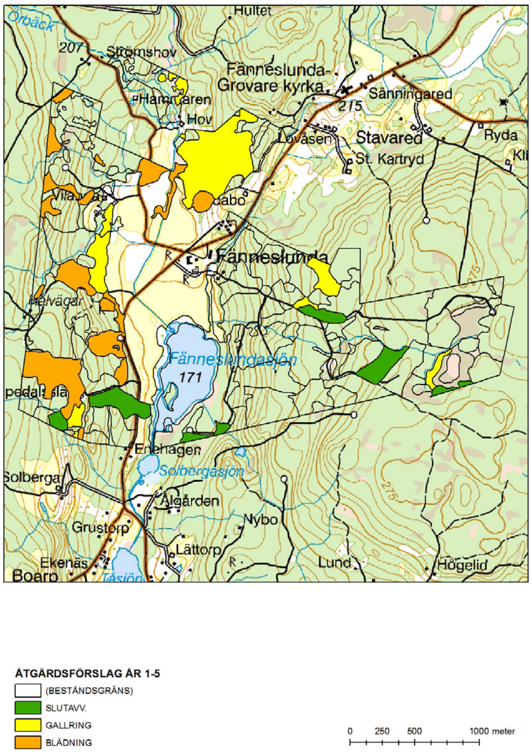

Figure 2. Map of the Fänneslunda forest estate showing harvest treatment proposals in years 1–5 following the scenario in which the forestry is adapted to social objectives such as recreational uses.

Tomas Lämås
Program Manager

Staff
Mona Bonta Bergman
Hampus Holmström
Anders Lundström
Peder Wikström
Karin Öhman

The program Forest Sustainability Analysis is a leading actor providing the target group with decision support tools and analyses related to long-term forest resource development including the production of goods and services.

More information:
Forest Sustainability Analysis,
www.slu.se/SHa.

Text and Figures:
Hampus Holmström, SLU.

Environmental Management System

Integration of the Department's goals and environmental goals

Dianne Staal Wästerlund
Co-ordinator

In 2013, the Department was awarded a renewed ISO 14001 certificate for its environmental management system. The revision concluded that the Department's management system was well adapted to the needs of the activities performed at the Department and that we had succeeded in implementing our environmental goals systematically in our activities. We managed to lower our CO_2 emissions on short (domestic) travel, which was one of our goals, and we increased the use of videoconference facilities. However, our total CO_2 emissions for traveling increased, and this indicates that the environmental research performed by the Department is appreciated by the academic community.

More information: Environmental Management System, www.slu.se/srh/miljocertifiering.

Text: Dianne Staal Wästerlund, SLU.
Figures: Viktor Wrange, SLU.

Publications

The publication list below includes work that was published during 2013. The publications are presented for each of the Department's competence areas and environmental monitoring programs separately. Peer reviewed scientific articles are listed first followed by proceedings, book chapters and reports. In the end of the publication list, articles in popular science are listed.

Remote Sensing

Scientific Articles

- Askne J.I.H., Fransson J.E.S., Santoro M., Soja M.J. and Ulander L.M.H. 2013. Model-based biomass estimation of a hemi-boreal forest from multitemporal TanDEM-X acquisitions. Remote Sensing, vol. 5, no. 11, pp. 5574-5597.
- Barth A. and Holmgren J. 2013. Stem taper estimates based on Airborne Laser Scanning and cut-to-length harvester measurements for pre-harvest planning. International Journal of Forest Engineering, vol. 24, no. 3, pp. 161-169.
- Chirici G., Scotti R., Montaghi A., Barbati A., Cartisano R., Lopez G., Marchetti M., McRoberts R.E., Olsson H. and Corona P. 2013. Stochastic gradient boosting classification trees for forest fuel types mapping through Airborne Laser Scanning and IRS LISS-III imagery. International Journal of Applied Earth Observation and Geoinformation, vol. 25, pp. 87-97.
- Gilichinsky M., Olsson H. and Solberg S. 2013. Reflectance changes due to pine sawfly attack detected using multitemporal SPOT satellite data. Remote Sensing Letters, vol. 4, no.1, pp. 10-18.
- Holmgren J. and Lindberg E. 2013. Tree crown segmentation based on a geometric tree crown model for prediction of forest variables. Canadian Journal of Remote Sensing, vol. 39, no. s1, pp. 86-98.
- Lindberg E., Holmgren J., Olofsson K., Wallerman J. and Olsson H. 2013. Estimation of tree lists from Airborne Laser Scanning using tree model clustering and *k*-MSN imputation. Remote Sensing, vol. 5, no. 4, pp. 1932-1955.
- Montaghi A. 2013. Effect of scanning angle on vegetation metrics derived from a nationwide Airborne Laser Scanning acquisition. Canadian Journal of Remote Sensing, vol. 39, no. s1, pp. 152-173.
- Montaghi A., Corona P., Dalponte M., Gianelle D., Chirici G. and Olsson H. 2013. Airborne Laser Scanning of forest resources: An overview of research in Italy as a commentary case study. International Journal of Applied Earth Observation and Geoinformation, vol. 23, pp. 288-300.
- Nyström M., Holmgren J. and Olsson H. 2013. Change detection of mountain birch using multi-temporal ALS point clouds. Remote Sensing Letters, vol. 4, no. 2, pp. 190-199.
- Persson H., Wallerman J., Olsson H. and Fransson J.E.S. 2013. Estimating forest biomass and height using optical stereo satellite data and a DTM from laser scanning data. Canadian Journal of Remote Sensing, vol. 39, no. 3, pp. 251-262.
- Ringdahl O., Hohnloser P., Hellström T., Holmgren J. and Lindroos O. 2013. Enhanced algorithms for estimating tree trunk diameter using 2D laser scanner. Remote Sensing, vol. 5, no.10, pp. 4839-4856.
- Santoro M., Cartus O., Fransson J.E.S., Shvidenko A., McCallum I., Hall R.J., Beaudoin A., Beer C. and Schmullius C. 2013. Estimates of forest growing stock volume for Sweden, Central Siberia, and Quebéc using Envisat Advanced Synthetic Aperture Radar backscatter data. Remote Sensing, vol. 5, no. 9, pp. 4503-4532.

Proceedings

- Fransson J.E.S., Wallerman J., Gustavsson A. and Ulander L.M.H. 2013. Estimation of stem volume in hemi-boreal forests using airborne low-frequency Synthetic Aperture Radar and lidar data. Proc. of IGARSS 2013, Building a Sustainable Earth through Remote Sensing, Melbourne, Australia, 22-27 July, 2013.
- Lindberg E., Hollaus M., Mücke W., Fransson J.E.S. and Pfeifer N. 2013. Detection of lying tree stems from Airborne Laser Scanning data using a line template matching algorithm. Proc. of ISPRS Workshop on Laser Scanning, Antalya, Turkey, 11-13 November, 2013.
- Nyström M., Holmgren J. and Olsson H. 2013. Detecting afforestation on individual tree level using ALS. Proc. of SilviLaser, Beijing, China, 9-11 October, 2013.
- Persson H. and Fransson J.E.S. 2013. Estimation of forest variables using radargrammetry on TerraSAR-X data in combination with a high resolution DEM. Proc. of ESA Living Planet Symposium, Edinburgh, UK, 9-13 September, 2013.
- Santoro M., Schmullius C., Pathe C., Schwilk J., Beer C., Thurner M., Fransson J.E.S., Shvidenko A., Schepaschenko D., McCallum I., Hall R. J. and Beaudoin A. 2013. Estimates of forest growing stock volume of the northern hemisphere from Envisat ASAR. Proc. of ESA Living Planet Symposium, Edinburgh, UK, 9-13 September, 2013.

Book Chapter

- Ågren J., Eklundh L., Olsson H., Harrie L. and Klang D. 2013. Insamling av geografiska data. 6 ed. Edited by L. Harrie. In Geografisk informationsbehandling: teori, metoder och tillämpningar, pp. 103-137.

Report

- Nordkvist K., Sandström E., Reese H. and Olsson H. 2013. Laserskanning och digital fotogrammetri i skogsbruket. 2 ed. Arbetsrapport, Sveriges lantbruksuniversitet, Institutionen för skoglig resurshushållning, vol. 407.

Eva Lindberg and Johan Holmgren were rewarded with the best paper award, 2013, in the Canadian Journal of Remote Sensing with their article "Tree crown segmentation based on a geometric tree crown model for prediction of forest variables".

Forest Inventory and Empirical Ecosystem Modeling

Scientific Articles

- Cronie O., Nyström K. and Yu J. 2013. Spatiotemporal modeling of Swedish Scots Pine stands. Forest Science, vol. 59, no. 5, pp. 505-516.
- Ehlers S., Grafström A., Nyström K., Olsson H. and Ståhl G. 2013. Data assimilation in stand-level forest inventories. Canadian Journal of Forest Research, vol. 43, no. 12, pp. 1104-1113.
- Ellison D., Petersson H., Lundblad M. and Wikberg P-E. 2013. The incentive gap: LULUCF and the Kyoto mechanism before and after Durban. Global Change Biology, Bioenergy, vol. 5, no. 6, pp. 599-622.
- Ene L.T., Næsset E., Gobakken T., Gregoire T.G., Ståhl G. and Holm S. 2013. A simulation approach for accuracy assessment of two-phase post-stratified estimation in large-area LiDAR biomass surveys. Remote Sensing of Environment, vol. 133, pp. 210-224.
- Grafström A. and Hedström Ringvall A. 2013. Improving forest field inventories by using remote sensing data in novel sampling designs. Canadian Journal of Forest Research, vol. 43, no. 11, pp. 1015-1022.
- Grafström A. and Lundström N. 2013. Why well spread probability samples are balanced. Open Journal of Statistics, vol. 3, no. 1, pp. 36-41.
- Grafström A. and Tillé Y. 2013. Doubly balanced spatial sampling with spreading and restitution of auxiliary totals. Environmetrics, vol. 24, no. 2, pp. 120-131.
- Hellsten S., Helmisaari H.S., Melin Y., Skovsgaard J.P., Kaakinen S., Kukkola M., Saarsalmi A., Petersson H. and Akselsson C. 2013. Nutrient concentrations in stumps and coarse roots of Norway spruce, Scots pine and silver birch in Sweden, Finland and Denmark. Forest Ecology and Management, vol. 290, pp. 40-48.
- Næsset E., Bollandsaå O.M., Gobakken T., Gregoire T.G. and Ståhl G. 2013. Model-assisted estimation of change in forest biomass over an 11 year period in a sample survey supported by airborne LiDAR: A case study with post-stratification to provide "activity data". Remote Sensing of Environment, vol. 128, pp. 299-314.
- Næsset E., Gobakken T., Bollandsås O.M., Gregoire T.G., Nelson R. and Ståhl G. 2013. Comparison of precision of biomass estimates in regional field sample surveys and airborne LiDAR-assisted surveys in Hedmark County, Norway. Remote Sensing of Environment, vol. 130, pp. 108-120.
- Ramezani H., Holm S., Allard A. and Ståhl G. 2013. A review of sampling-based approaches for estimating landscape metrics. Norsk Geografisk Tidsskrift-Norwegian Journal of Geography, vol. 67, no.2, pp. 61-71.
- Ramezani H. and Holm S. 2013. Estimating a distance dependent contagion function using point sample data. Environmental and Ecological Statistics, vol. 21, no. 1, pp. 61-82.
- Schnell S., Wikman J. and Ståhl G. 2013. Relascope sampling for crown ratio estimation. Canadian Journal of Forest Research, vol. 43, no. 5, pp. 459-468.
- Ståhl G., Heikkinen J., Petersson H., Repola J. and Holm S. 2013. Sample based estimation of greenhouse gas emissions from forests – a new approach to account for both sampling and model errors. Forest Science, vol. 60, no. 1, pp. 3-13(11).
- Suty N., Nyström K. and Ståhl G. 2013. Assessment of bias due to random measurement errors in stem volume growth estimation by the Swedish National Forest Inventory. Scandinavian Journal of Forest Research, vol. 28, no. 2, pp. 174-183.

Book Chapters

- Karltun E., Lundblad M. and Petersson H. 2013. KP-LULUCF. In National Inventory Report 2013 Sweden - submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, pp. 401-415.

Figure:
Emma Sandström, SLU.

- Karltun E., Lundblad M. and Petersson H. 2013. Land Use, Land-Use Change and Forestry (CRF sector 5). In National Inventory Report 2013 Sweden - submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, pp. 271-304.

Forest Planning

Scientific Articles

- Korosuo A., Holmström H., Öhman K. and Eriksson L.O. 2013. Using value functions to elicit spatial preference information. European Journal of Forest Research, vol. 132, no. 3, pp. 551-563.
- Kraxner F., Nordström E-M., Havlik P., Gusti M., Mosnier A., Frank S., Valin H., Fritz S., Fuss S., Kindermann G., McCallum I., Khabarov N., Boettcher H., See L., Aoki K., Schmid E., Mathe L. and Obersteiner M. 2013. Global bioenergy scenarios - Future forest development, land-use implications, and trade-offs. Biomass and Bioenergy, vol. 57, pp. 86-96.
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- Nordström E-M., Holmström H. and Öhman K. 2013. Evaluating continuous cover forestry based on the forest owner's objectives by combining scenario analysis and multiple criteria decision analysis. Silva Fennica, vol. 47, no. 4.
- Pasalodos-Tato M., Mäkinen A., Garcia-Gonzalo J., Borges J.G., Lämås T. and Eriksson L.O. 2013. Assessing uncertainty and risk in forest planning and decision support systems. Forests Systems, vol. 22, no. 2, pp. 282-303.
- Nilsson M., Eriksson L.O. and Staal Wästerlund D. 2013. Strategy pattern creation in forest planning in Swedish forest-owning companies. Forests, vol. 4, no. 3, pp. 553-574.

Proceedings

- Holmström H., Wikström P. and Berglund M. 2013. Optimal allocation of harvest levels to forest estates within a geographically scattered forest holding. Proc. of Implementation of DSS Tools into the Forestry Practice, Zvolen, Slovakien, 10-12 May, 2012.

Report

- Öhman K., Holmström H. and Nordström E-M. 2013. Utvärdering av kontinuitetsskogsbruk för Linköpings kommunskogar. Arbetsrapport, Sveriges lantbruksuniversitet, Institutionen för skoglig resurshushållning, vol. 385.

Forest in Rural Studies and International Forestry

Scientific Articles

- Häggström C., Kawasaki A. and Lidestav G. 2013. Profiles of forestry contractors and development of the forestry-contracting sector in Sweden. Scandinavian Journal of Forest Research, vol. 28, no. 4, pp. 395-404.
- Klenk N.L., Reed M.G., Lidestav G. and Carlsson J. 2013. Models of representation and participation in model forests: Dilemmas and implications for networked forms of environmental governance involving indigenous people. Environmental Policy and Governance, vol. 23, no. 3, pp. 161-176.
- Lidestav G. and Lejon S.B. 2013. Harvesting and silvicultural activities in Swedish family forestry - behavior changes from a gender perspective. Scandinavian Journal of Forest Research, vol. 28, no. 2, pp. 136-142.
- Lidestav G., Poudyal M., Holmgren E. and Keskitalo E.C.H. 2013. Shareholder perceptions of individual and common benefits in Swedish forest commons. International Journal of the Commons, vol. 7, no. 1, pp. 164-182.
- Umaerus P., Lidestav G., Eriksson L.O. and Högvall Nordin M. 2013. Gendered business activities in family farm forestry: From round wood delivery to health service. Scandinavian Journal of Forest Research, vol. 28, no. 6, pp. 596-607.
- Vestin J.L.K., Söderberg U., Bylund D., Nambu K., van Hees P.A.W., Haslinger E., Ottner F. and Lundström U.S. 2013. The influence of alkaline and non-alkaline parent material on Norway spruce tree chemical composition and growth rate. Plant and Soil, vol. 370, no. 1-2, pp. 103-113.

Proceedings

- Erlandsson E., Lidestav G. and Fjeld D. 2013. The impact of industrial context on procurement and management of harvesting services - A comparison between two Swedish forest owners associations. Proc. of OSCAR Workshop on Contractor Forestry, 12-13 November, 2013.
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- Sandewall M. 2013. Could forecasting be a possible tool for developing forest management strategies in Vietnam? Proc. of Workshop "Forestry sector forecasting: Status and develpement needs", Quang Ninh, Vietnam, 28-29 August, 2013.

- Söderberg U. 2013. A Swedish model for data collection and its use in forest sector forecasting. Proc. of workshop "Forestry sector forecasting: Status and developement needs", Quang Ninh, Vietnam, 28-29 August, 2013.

Report

- Skarin A., Nellemann C., Sandström P., Rönnegård L. and Lundqvist H. 2013. Renar och vindkraft, Studie från anläggningen av två vindkraftparker i Malå sameby. Naturvårdsverket, Rapport 6564.

National Forest Inventory

Scientific Articles

- Gamfeldt L., Snäll T., Bagchi R., Jonsson M., Gustafsson L., Kjellander P., Ruiz-Jaen M.C., Fröberg M., Stendahl J., Philipson C.D., Mikusinski G., Andersson E., Westerlund B., Andrén H., Moberg F., Moen J. and Bengtsson J. 2013. Higher levels of multiple ecosystem services are found in forests with more tree species. Nature Communications, no. 4.
- Kruys N., Fridman J., Götmark F., Simonsson P. and Gustafsson L. 2013. Retaining trees for conservation at clearcutting has increased structural diversity in young Swedish production forests. Forest Ecology and Management, vol. 304, pp. 312-321.
- Marini L., Lindelöw A., Jonsson A.M., Wulff S. and Schroeder L.M. 2013. Population dynamics of the spruce bark beetle: A long-term study. Oikos, vol. 122, no. 12, pp. 1768-1776.
- Vilà M., Carrillo-Gavilán A., Vayreda J., Bugmann H., Fridman J., Grodzki W., Haase J., Kunstler G., Schelhaas M. and Trasobares A. 2013. Disentangling biodiversity and climatic determinants of wood production. Plos One, vol. 8, no. 2, pp. 1-9.
- Wulff S., Roberge C., Hedström Ringvall A., Holm S. and Ståhl G. 2013. On the possibility to monitor and assess forest damage within large scale monitoring programmes - A simulation study. Silva Fennica, vol. 47, no. 3.

Reports

- Nilsson P., Cory N., Fridman J. and Kempe G. 2013. Skogsdata 2013. Aktuella uppgifter om de svenska skogarna från Riksskogstaxeringen. Tema: Olika mått på skogens ålder och trädslagssammansättning.
- Wulff S. and Hansson P. 2013. Nationell Riktad Skadeinventering (NRS) 2012. Arbetsrapport, Sveriges lantbruksuniversitet, Institutionen för skoglig resurshushållning, vol. 386.
- Wulff S. 2013. Nationell Riktad Skadeinventering (NRS) 2013. Arbetsrapport, Sveriges lantbruksuniversitet, Institutionen för skoglig resurshushållning, vol. 406.

National Inventory of Landscapes in Sweden

Scientific Articles

- Callaghan T.V., Jonasson C., Thierfelder T., Yang Z., Hedenås H., Johansson M., Molau U., Van Bogaert R., Michelsen A., Olofsson J., Gwynn-Jones D., Bokhorst S., Phoenix G., Bjerke J.W., Tommervik H., Christensen T.R., Hanna E., Koller E.K. and Sloan V.L. 2013. Ecosystem change and stability over multiple decades in the Swedish subarctic: Complex processes and multiple drivers. Philosophical Transactions of the Royal Society B: Biological Sciences, vol. 368, no. 1624, pp. 1471-1489.
- Christensen P. and Hedström Ringvall A. 2013. Using statistical power analysis as a tool when designing a monitoring program: Experience from a large-scale Swedish landscape monitoring program. Environmental Monitoring and Assessment, vol. 185, no. 9, pp. 7279-7293.
- Daehne M., Gilles A., Lucke K., Peschko V., Adler S., Kruegel K., Sundermeyer J. and Siebert U. 2013. Effects of pile-driving on harbour porpoises (Phocoena phocoena) at the first offshore wind farm in Germany. Environmental research Letters, vol. 2, no. 8.
- Grandin U., Lenoir L. and Glimskär A. 2013. Are restricted species checklists or ant communities useful for assessing plant community composition and biodiversity in grazed pastures? Biodiversity and Conservation, vol. 22, no. 6-7, pp. 1415-1434.

Reports

- De Blust G.,Laurijssens G., Van Calster H., Verschelde P., Bauwens D., De Vos B., Svensson J. and Jongman R. 2013. Design of a monitoring system and its cost effectiveness. Alterra Report 2393.
- Glimskär A., Andersson P. and Pettersson A. 2013. Årsrapport för Regional miljöövervakning via NILS, år 2012.

Popular Science

- Lundström J., Gustafsson L., Rönnqvist M. and Öhman K. 2013. Unga skogar - ett kostnadseffektivt reservatsalternativ. Fakta Skog no. 13, SLU.
- Ellison, D., Petersson, H., and Lundblad, M. 2013. The cost efficient inclusion of LULUCF in the EU climate policy framework, opinions, comments, information on the world economy.
- Sandewall M. 2013. Swedish influence behind gigantic landscape transition. SIFI Nyhetsbrev, no. 11, p. 8.
- Schroeder M. and Wulff S. 2013. Dukat bord efter Dagmar. Skogseko, vol. 28, no. 1, pp. 43.
- Schroeder M., Lindelöw Å., Wulff S. and Jönsson A.M. 2013. Vindfällen och konkurrens styr hur många granbarkborrarna blir. Skogseko, vol. 28, no. 3, p. 41.

Field Staff

Every year the Department organizes and implements extensive inventories of forests and landscapes in Sweden. To carry out this work a number of field workers are employed.

National Forest Inventory

Leif Andersson
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National Inventory of Land-scapes in Sweden

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Since 1923 the National Forest Inventory has collected data and delivered statistics from Swedish forests. During 2013 they celebrated their 90th anniversary.

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