SLU

Department of Forest Resource Management

# Annual Report 2012

INTERTEK ISO 14001:2004

Johan Fransson
Head of Department

Contents



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Sofia Hansson
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# Dear Reader,

The time has come to encourage you to learn a little bit more about the Department's activities during 2012! These include undergraduate, Master's and doctoral studies, and research within six competence areas (research groups), as well as three major programmes of environmental monitoring along with communicating information to our society. In addition, you can read about the programme of Forest Sustainability Analysis (spanning all of the competence areas and environmental monitoring programmes at the Department) and last but not least about our work with the Department's Environmental Management System.

The year has (as always!) been very hectic and a lot of energy was given to shape and strengthen the Department to prepare for future challenges. To mention a few important highlights it was decided that the Unit of Forest Technology within the Section of Forest Planning and Operations Management should make up a part of a new department; therefore they were to be separated from the Department as of January 1, 2013. Another investigation that was performed during the year led to a decision by the Faculty to move the competence area of Forest Mathematical Statistics to our Department. We formulated a new goals and strategies document for the years 2013-2015 for research, education and environmental monitoring to be conducted at the Department. At the end of 2012 we also began our move back into the main building from the temporary barracks. Despite all the changes and planning for the future we were able to successfully concentrate on our present tasks without any decrease in productivity. For example, we increased our publication rate and successfully completed our projects in a wide range of topics. This could only be achieved by having such dedicated and capable staff!

The achievements of the Department are based on team and individual efforts and contributions that all definitely deserve to be mentioned. This is unfortunately an impossible task. Nevertheless, I would like to highlight a few important occurrences with respect to the staff during 2012:

- David Alger was appointed chairman of the Working Committee of System Development
- Mikaela Asplund was appointed as operational developer at the support organisation for Environmental Monitoring and Assessment Data
- Andreas Pantze, Thomas Ulvcrona and Peder Wikström left the Department and are now involved in new challenges
- Svante Lindroth retired from the Department after serving SLU for more than 30 years
- Kenneth Nyström was honored in a special celebration for employees that have served the government for 30 years

It is also my duty to inform you of the sad events as well, which is that during the year we lost two of our dear colleagues, Bengt Jonsson and Nelson Sherman (please read more on page 31).

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

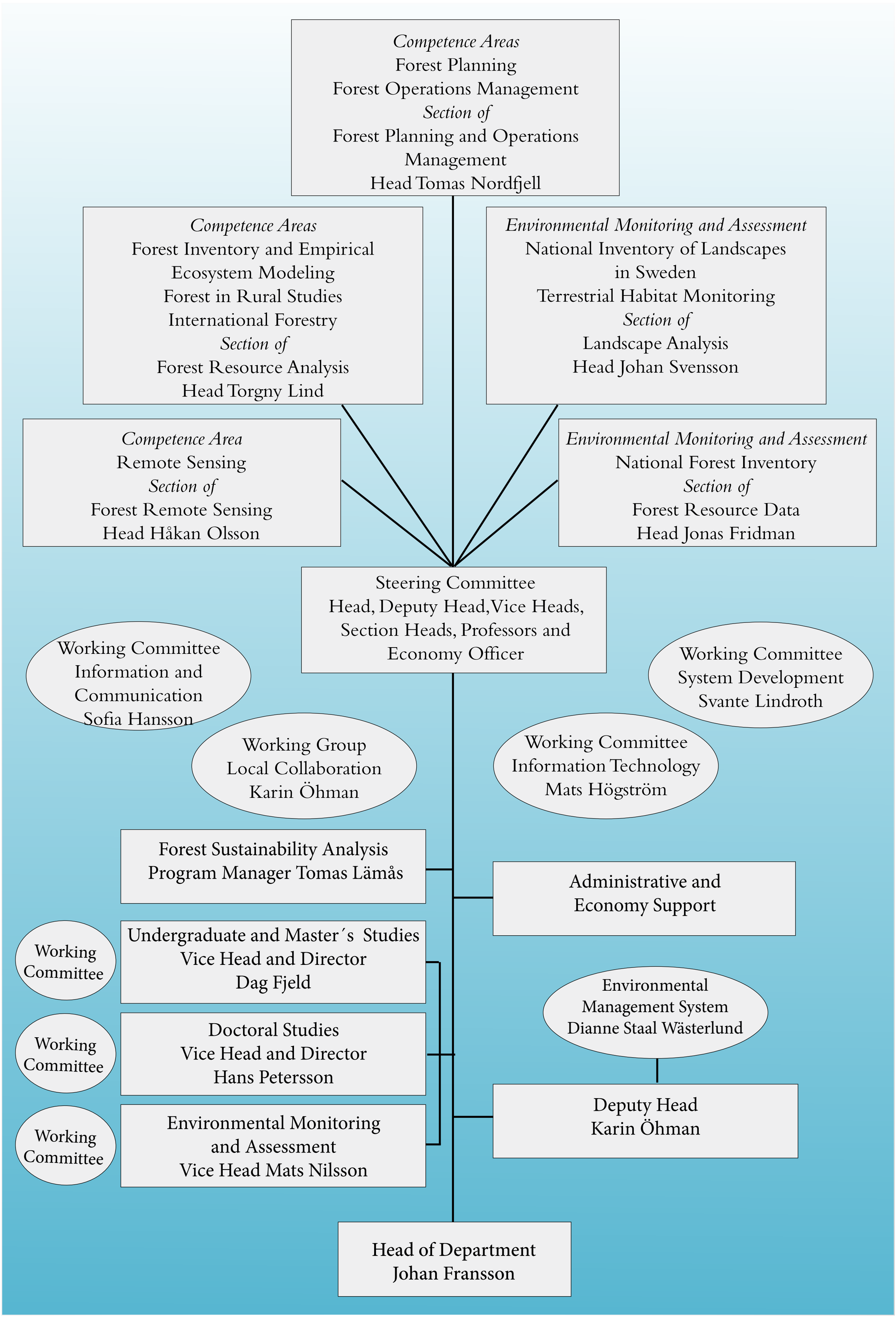



Figure: Sofia Hansson

# Department Photos

## Department Steering Committee

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 six more indepth meetings during 2012.

**In the photo:**
**Tomas Nordfjell**
**Ola Eriksson**
**Emanuel Erlandsson**
**Håkan Olsson**
**Johan Svensson**
**Pär Andersson**
**Mats Nilsson**
**Hans Petersson**
**Torgny Lind**
**Jonas Fridman**
**Johan Fransson**
**Karin Öhman**

**Missing:**
Dag Fjeld
Iwan Wästerlund
Göran Ståhl

## Administrative and Economy Support

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.

**In the photo:**
Sofia Hansson,
Information Officer
Anne-Maj Jonsson,
Economy Officer
Nanna Hjertkvist,
Administrator
Pär Andersson,
Economy Officer
Linda Ågren,
Economist
Carina Westerlund,
Administrator
Ylva Jonsson,
Economy Administrator

## Employees at the Department 2012

On 23th of October the staff gathered for a Department day at Scandic Plaza Hotel in Umeå – a facility used for fairs, seminars, conferences, sport and recreational activities – to discuss this year's theme: Common basis of values - Co-operation. Starting with some department information, follow up of the Goals and starategies document for 2009-2012 and group discussions about Goal and Strategy document for 2013-2015.

Text: :Johan Fransson
Photo: Sofia Hansson

# Press Clippings

**Helgeå is part of a 30 million crown project**
Helgeå is set to become a model for sustainable forest development. A project in Kristanstad has now been initiated. -Finding common issues which can be focused upon, or ways of working, explains Associate Professor Gun Lidestav from the Department of Forest Resource Management at SLU in Umeå, the projects coordinator. 30 million Swedish crowns from the Baltic Sea Region Programme have been allocated to the project titled "The Baltic landscape in change" which runs until from this year until 2014.
*Published 7th February 2012*
*Kristianstadsbladet.se*

**Using laser scanning within forest and nature conservation planning**
With laser scanning, both forestry and nature conservation planning have a new and effective tool which can be used in inventory work and planning. Eva Lindberg at SLU has developed methods for measuring vegetation in different layers.
*Published 5th June*
*Skogssverige.se*

**Sweden already has a good forest policy**
There is currently ongoing work which addresses the issues that the Swedish Society for Nature Conservation (SSNC) is trying to reach through new legislation. Sustainable environmental work takes time. The SSNC should wait for the results of this ongoing work before they demand changes in the current forest policy. Those working with the environmental objective Sustainable Forests are convinced this ongoing work is giving positive results. According to data from the Swedish National Forest Inventory the amount of hard dead wood, area old forest and area deciduous rich forest have all increased and have not subsequently declined.
*Published 22nd May 2012*
*Dagens Nyheter*

**What is the price of clearcutting?**
Linköping council is examining the possibility of moving over to continuous cover forestry for all of its 2400 hectares of forest. A consequence of this would be a reduction in the current value of the forest with 30 percent compared with current management – explained SLU-researcher Hampus Holmström during the Swedish Forestry Association's autumn excursion.
*Published September 2012*
*Skogen.se*

**Here's how a forest owner can get paid more**
Researchers at SLU in Umeå have studied three forest holdings in different parts of the country: Jämtkrafts forests outside of Östersund, Skellefteå Krafts forests in northern Västerbotten and Gothenburg's stadsskogar. The aim is to show that a higher profitability can be obtained through better planning.
*Published 12th November 2012*
*Länstidningen Östersund*

**HEUREKA – forestry on your terms**
Researchers Hampus Holmström and Karin Öhman work with developing Heurekas planning tool for impact assessment and long term strategic planning within forest management - with funding from the Swedish Forestry Society and Future Forests. The advanced analysis tool Heureka, developed by researchers and tested by the forestry sector, helps guide forest owners to better results. Using the Heureka system a forest owner can examine the consequences of different forest management strategies such as different management intensities or management with a focus on more than just timber production.
*Published February 2012*
*Skogssällskapet.se*

**Success for free access to geographic data for the research community**
SLU has been given responsibility of providing access to Lantmäteriets geodata to Swedish universities via a service developed at SLU and funded by the Swedish Research Council. Already during the first week 16 universities joined the service which gives researchers and students free access to a large range of the geographical information contained in Landmäteriets databases.
*Published 20th December 2012*
*Lantmäteriet.se*

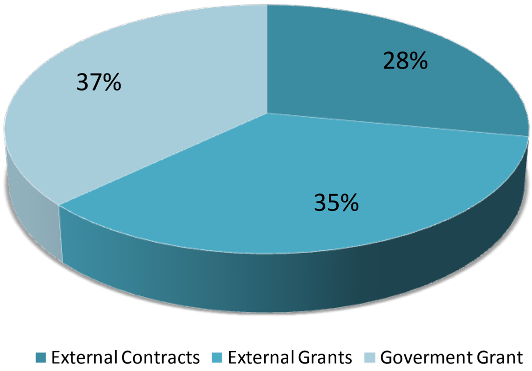
**Swedish Society for Nature Conservation's model expensive for Swedish forests**
What effects would an increased level of environmental management have for the forestry sector? This was one of the issues discussed at Virkesforum in Stockholm which took place this week.
*Published 13th September 2012*
*ATL Lantbrukets affärstidning*

**With a focus on bio-energy**
When the Department of Energy held its annual conference Energiutblick one of the subjects examined was recovering bio-energy from the Swedish forests.
*Published 27th May 2012*
*Skogsaktuellt*

# Facts and Figures

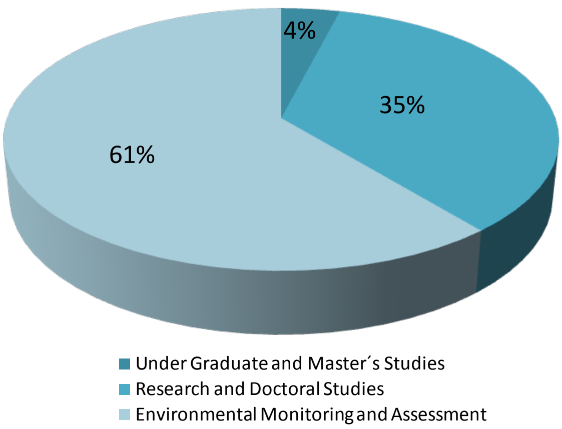
## Revenues

| Revenues (1000 SEK) | Undergraduate and Master´s Studies | Research and Doctoral Studies | Environmental Monitoring and Assessment | Support Function | Total |
|---|---|---|---|---|---|
| Government grants | 5 273 | 18 436 | 27 637 | 900 | 52 246 |
| External contracts | 123 | 4 319 | 35 183 | 246 | 39 871 |
| External grants | 271 | 25 448 | 22 795 | 85 | 48 599 |
| Other revenues | 0 | 39 | 28 | 170 | 237 |
| **Total** | **5 667** | **48 242** | **85 643** | **1 401** | **140 953** |




## Costs

| Costs (1000 SEK) | Undergraduate and Master´s Studies | Research and Doctoral Studies | Environmental Monitoring and Assessment | Support Function | Total |
|---|---|---|---|---|---|
| Staff | 4 000 | 29 616 | 52 998 | 5 702 | 92 316 |
| Premises | 689 | 1 741 | 1 643 | 2 193 | 6 266 |
| Other operative expenses | 471 | 11 468 | 17 939 | 3 108 | 32 986 |
| Depreciation | 3 | 32 | 531 | 49 | 615 |
| Overheads | 1 339 | 9 622 | 14 530 | -9 909 | 15 582 |



## External Contracts and Grants

| **Financier** | **Incomings (million SEK)** |
|---|---|
| EU | 34.8 |
| Swedish Environmental Protection Agency | 16.7 |
| Swedish Board of Agriculture | 4.3 |
| Formas | 3.7 |
| County Administrative Boards | 2.6 |
| The Swedish Forest Society | 2.4 |
| Forestry Research Institute of Sweden | 2.1 |
| Swedish National Space Board | 1.9 |
| Södra | 1.7 |
| Swedish Research Council | 1.2 |
| The Royal Swedish Academy of Agriculture and Forestry | 0.8 |
| Kempe Foundations | 0.8 |
| Swedish District Heating Association | 0.7 |
| Swedish Forest Agency | 0.7 |
| The Foundation for Strategic Environmental Research | 0.6 |
| Swedish Farmers´Foundation for Agricultural Research | 0.6 |
| Brattås Foundation | 0.6 |
| Norra Skogsägarna | 0.5 |
| Swedish Energy Agency | 0.4 |
| Ljungbergs Foundation | 0.3 |
| Saami Parliament | 0.2 |
| Fonden för skogsvetenskaplig forskning | 0.2 |
| Mid Nordic Business Arena | 0.2 |
| Swedish Forest Industries Federation | 0.1 |
| Efokus AB | 0.1 |
| The Swedish Machinery Testing Institute | 0.1 |
| Önnesjöstiftelsen | 0.1 |
| SCA | 0.1 |
| Bröderna Edlunds donationsfond | 0.1 |
| Banum | 0.1 |
| Nordic Forest Research Co-operation Committee | 0.1 |
| Others | 9.7 |

## Personnel Categories

| **Personnel Categories** | **Number of Work-Years*** |
|---|---|
| Professors | 4,2 |
| Associate professors/University lecturers | 10,3 |
| Assistent professors | 3,1 |
| Researchers | 25,8 |
| Post doctoral students | 3,5 |
| Doctoral students | 23,1 |
| Other tearchers | 1,5 |
| Administrative staff | 9,5 |
| Technical staff | 35,4 |
| Technical staff (field) | 42,8 |
| **Total staff** | **159,2** |

*These figures show the number of work-years at the Department. It´s not a true reflection of the number of employees.

Tables: Pär Andersson and Anne-Maj Jonsson
Figures: Sofia Hansson

# Undergraduate and Master's Studies

Dag Fjeld
Vice Head and Director Undergraduate and Master's Studies

**The department** is a major contributor to SLU's Master of Forestry Programme (Jägmästarut-bildningen). Our course selection amounts to over 40 ECTS credits at Bachelor's level and 80 ECTS credits at Master's level. The courses are given in six areas: Remote Sensing and Geographic Information Technology (GIT), Forest Inventory, Forest Planning, Forest Technology, Wood Supply, and Organization and Leadership.

Curriculum development is handled by subject coordinators Jonas Bohlin (Remote Sensing and GIT), Anna Hedström Ringvall (Forest Inventory), Erik Wilhelmsson (Forest Planning), Dag Fjeld (Forest Technology and Wood Supply) and Dianne Staal Wästerlund (Organization and Leadership).

The individual courses for each subject are shown in Table 1, divided into Bachelor's and Master's studies. Courses at Bachelor's level have 40 to 80 students per course. Courses at Master's level generally have 5 to 30 students per course.

**Highlights for 2012**. The area of remote sensing has seen increased development activity this year with a completely new course in laser scanning and digital photogrammetry, enabled by support from the Ljungberg Foundation.

The area of forest planning has also seen increased activity this year. Training with the the new HEUREKA decision support system set the year's record for course popularity at Master's level with almost 40% of all Jägmästare choosing this course. The course was also nominated for this year's pedagogical prize for excellence in rapid implementation of research results. The forest planning group has also now initiated an external review of current curriculum and development needs for both remote sensing, forest inventory and forest planning which is scheduled for the spring of 2013. More development efforts await!

The area of forest technology, after an analysis in 2011 of gaps between sector needs and current curriculum, has been supplemented with expert instruction from the Swedish Forest Service for road net planning and construction. This has resulted in both updated teaching material and new planning and laboratory exercises for 2012. The year's Master's level training in wood supply saw the highest number of students ever to complete the whole 45 credits course package (22 jägmästare). The year also saw new road and transport exercises added to the package, thanks to external organisations such as SkogForsk, resulting in student work averaging over 50 hours per week in the main course in forest operations planning and control.

The year concluded with the SLU team beating American, Canadian and South African teams in an international wood supply competition.

During 2012, the total volume of teatching performed at the department was 107 full-time equivalents, corresponding to 98 annual performance equivalents. Approximatly 13.8% of the total volume comes from master's theses (19 completed in 2012), the majority of which were externally sponsored.

**Strategic goals.** The long-term goal for educational activities at the department is to deliver relevant competence to the forest sector through high quality instruction. Annual progress towards these goals is measured by a number of performance indicators (Figure 1). These include external and internal participation in curriculum development, number of lecturers per subject area, student course evaluations and number of Master's theses completed at the department.

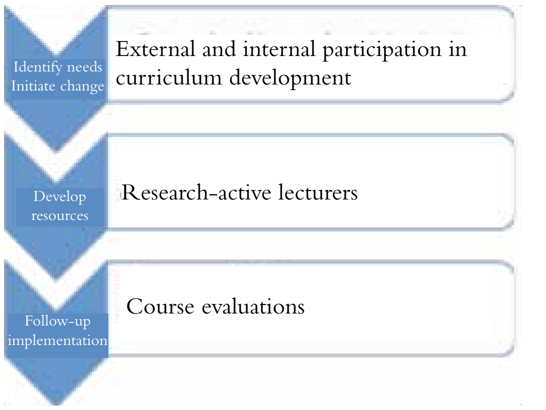



Figure 1. SRH's strategy for education development showing the three main elements (left) and respective performance indicators (right).

### Courses Given at the Department in 2012

| **Subject** | **Undergraduate Level** (years 1-3)<br>40-80 students per course | **Master´s Level** (years 4-5)<br>5-50 students per course |
|---|---|---|
| Remote Sensing and GIT | Basic GIT | Advanced GIT<br>Forest Remote Sensing |
| Forest Inventory | Silviculture and Forest Inventory | |
| Forest Planning | Basic Forest Planning | Company-Level Forest Planning |
| Forest Operations Management | Forest Production and Forest Products Processing<br>Forest Technology | Innovations in Nordic Forest Technology |
| Wood Supply | Market-Oriented Wood Supply | Industrial Supply Strategy<br>Operational Planning and Control<br>Business Processes and Information Systems |
| Organization and Leadership | Individual and Group Leadership | Organizational Development in the Forest Sector |
| Master of Environmental Moni-toring and Assessment | | GIT |

Text, Figure and Table: Dag Fjeld

# Master's Theses Reports

## Remote Sensing

Jonsson, Elin, 2012 Method for mapping deciduous raw material in the operating area of Södra Skog. (Supervisor: Mats Nilsson)

Martin, Jennifer, 2012. Mapping wetland areas on forested landsacpes using Radarasat-2 and Landsat-5 TM data. (Supervisor: Heather Reese)

Lindgren, Nils, 2012 Laser data based classification of mountain birch forest according to the FAO definition of forested land (Supervisor: Karin Nordqvist)

Puliti, Stefano , 2012. Analyses of the feasibility of participatory REDD+ MRV approaches to Lidar assisted carbon inventories in Nepal. (Supervisor: Johan Holmgren)

## Forest Inventory and Empirical Ecosystem Modeling

Chen, Cen, 2012. Modeling historical forest landscape in the county of Halland, Sweden using data from the first National Forest Inventory. (Supervisor: Axelsson, Anna-Lena)

Forslund, Ambjörn , 2012. Framtida potential för skogsbränslen i Sverige. (Supervisor: Torgny Lind)

Wikman ,Jonas, 2012. Relascope sampling for crown ratio estimation, a new method for determining thinning needs (Supervisor: Göran Ståhl)

## Forest Planning

Alm, Johan, 2012 The forest management plan and its effect on the management activities of NIPF owners in northern Sweden (Supervisor: Erik Wilhelmsson)

Andersson, Erik, 2012. Forest management strategies developed for private forest owners members in Forest Owner Association Norrskog (Supervisor: Erik Wilhelmsson)

Johansson, Håkan, 2012. Tactical planning with geographic consideration-Case study with Heureka PlanWise at SCA Skogs district Liden(Supervisor: Peder Wikström)

Olofsson, Daniel, 2012. SWOT- analysis of Bracke Forest C.16b head for biofuel harvest (Supervisor: Erik Wilhelmsson)

Schönning, Erik, 2012 The next generation forest owners and their need of services and counseling-A survey among grown-up children to present members of Mellanskog (Supervisor: Diane Staal Wästerlund)

## Forest Operations Management

Boman, Josefin, 2012. SCA Forests methods to determine the value of a road investment. (Supervisor: Iwan Wästerlund)

Ekström, Axel, 2012 Mapping saw-dust products at Sävar såg (Supervisor: Iwan Wästerlund)

Grönlund, Örjan, 2012. Pricing models for ballast hauling- In construction and maintenance of forest truck roads (Supervisor: Dag Fjeld)

Tiger, Karl, 2012. Comparison of estimated and driven forwarding distance (Supervisor: Ola Lindroos)

Vestling, Björn, 2012. Factors influencing costs for harvestersAn analysis of follow-up data at Stora Enso Skog(Supervisor: Ola Lindroos)

Wålberg Von Knorring, Mattias, 2012. Decision support system for locating main forwarding roads and calculating the average terrain transport distance (Supervisor: Iwan Wästerlund)

## Forest in Rural Studies

Carlsson, Julia, 2012. Examining the social component of sustainable forest management in Prince Albert and Vilhelmina Model Forests. (Supervisor: Gun Lidestav)

## Arvid Lindman's Award 2012

Martin Sjödin was awarded for his Master´s thesis entitled " Airborne laser scanning data estimates for forests that are candidates for thinning cuttings - calculations of volume density"
(Supervisor: Johan Holmgren)

**More information:**
The Master´s thesis reports can be found in SLU´s digital archive Epsilon, http://epsilon.slu.se

# Doctoral Studies

Hans Petersson
Vice Head and Director
Doctoral Studies

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

**In 2012, a total of 32 active students** were enrolled: 19 men and 13 women. Two PhD students completed their studies, resulting in one doctoral degree and one licentiate degree, and three new students were recruited. Four, 13, 8, 6 and 1, students passed 0, 25, 50, 75 and 100% of their examinations, respectively.

**The PhD students made great progress,** and their research resulted in co-authorship of scientific publications. In addition, the PhDs who had completed their doctorates the previous year, published several manuscripts from their thesis's. 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 in a PhD student day organised by the Department. Representative students have taken part in the Working Committee of Doctoral Studies (Department level) and the Council of Doctoral Students (self-organised).

Currently 15 different senior researchers act as supervisors; the PhD students are supported by about 35 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. Then the Department's director of PhD studies reports the outcome of this review to the Faculty. The director of PhD studies at the Faculty organises meetings of the Department directors annually; the aim of these meetings is to provide information about new regulations and facilitate harmonisation of the various PhD studies.

**During 2012, the Department gave** these scheduled courses at PhD level: Forest Remote Sensing, 3D Remote Sensing of Forests, Statistical Methods for Research with Focus on Application, Model-Assisted Survey Sampling, Gender and Natural Resource Management (part I), Sampling and Data Acquisition and Image Analysis.

**Courses Given at the Department in 2012**

| Subject | Credits (ECTS) |
|---|---|
| Forest Remote Sensing | 7.5 HEC |
| 3D Remote Sensing of Forests | 5.0 HEC |
| Statistical Methods for Research with Focus on Application | 7.5 HEC |
| Model-Assisted Survey Sampling | 8.0 HEC |
| Gender and Natural Resource Management (part I) | 3.0 HEC |
| Sampling and Data Acquisition | 7.5 HEC |
| Image Analysis | 7.5 HEC |

Text: Hans Petersson, SLU
Photo: Viktor Wrange, SLU

# Theses

## Doctorate – Remote Sensing

**Eva Lindberg**
Estimation of Canopy Structure and Individual Trees from Laser Scanning Data

Dissertation: June
Supervisor: Professor Håkan Olsson
Assistant supervisors: Associate Professor Johan Holmgren, Doctor Kenneth Olofsson and Doctor Jörgen Wallerman

## Licentiate – Forest Operational Management

**Jeannette Edlund**
Harvesting in the boreal forest on soft ground

Dissertation: October
Supervisor: Professor Urban Bergsten
Assistant supervisor: Professor Håkan Olsson and Doctor Urban Nordmark

## "Forestry Faculty's promoter"

Professor Håkan Olsson (center) and his two newly graduated doctoral students, Eva Lindberg (left) and Heather Reese (right), at the October 6, 2012 graduation ceremony in Ultuna. Håkan served as the Forestry faculty's promoter at the graduation ceremony. Photo: Viktor Wrange, SLU

**More information:** The doctoral theses can be found in SLU´s digital archive Epsilon, http://epsilon.slu.se

Text: Heather Reese
Photo: Sofia Hansson, SLU and Viktor Wrange, SLU

Håkan Olsson
Competence Area Manager

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

**Post Doctor**
Alessandro Montaghi

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

Text and Figures:
Heather Reese

# Mapping mountain vegetation with optical satellite data

**The mountainous areas of Sweden** consist of vegetation such as mountain birch forests, low- growing heaths and high alpine meadows, which can occur in a heterogeneous mosaic. Due to the potential sensitivity of mountain vegetation to climate change, as well as interest in the mountains for the purposes of tourism or reindeer management, several actors would like access to up-to-date and detailed map data. The currently available Mountain Vegetation Map is relatively outdated since it is based on aerial photographs from the 1970s. The subject of Heather Reese's recent PhD dissertation was to test the creation of mountain vegetation maps based on optical satellite data. The work was carried out in a 100 × 100 km area in the Vindelfjällen Nature Reserve. Using a combination of SPOT 5 (10 m pixel) satellite data, elevation data from the 50 m grid Digital Elevation Model (DEM) and reference data taken from field and aerial photos from the NILS program, maps with detailed vegetation classes could be produced. The classes were similar to those in the Mountain Vegetation Map, including grass heath, mesic heath, dry heath, extremely dry heath, short alpine meadow, tall alpine meadow, wetland, snow bed vegetation, bare rock and mountain birch. The classes were based on species composition, as well as height and density specifications. Overall map accuracy for 11 alpine vegetation classes was approximately 73%, of which the addition of the elevation data contributed 9%.

**The recent nation-wide airborne LiDAR scanning** campaign by Lantmäteriet is being used to create a National Height (NH) model with a 2 m grid cell as well as make the LiDAR data point clouds available. Lantmäteriet has scanned a 25 × 31 km test area near Abisko, in northern Sweden. As a continuation of the methods developed in the dissertation work, the SPOT 5 satellite data have been combined with the 2 m DEM, as well as metrics created from the LiDAR point cloud. One difficulty in the classification of satellite data for mountain vegetation is that some classes are spectrally similar to each other and cause classification errors. Therefore, it was of interest to improve the results by combining satellite data and both the 2m DEM and LiDAR data point cloud that provides measurements of vegetation height and density. It was found that the addition of metrics from the LiDAR point cloud data improved the overall classification accuracy by 6% as compared to using just SPOT 5 and the 2m DEM data; specifically, the LiDAR metrics improved the accuracy of the classes willow, mesic heath, and mountain birch, which are spectrally similar but differ in vegetation height and species composition. It appears that for the classification of willow, all three data sources (satellite data, elevation data, and the LiDAR point cloud) contribute to better identification. PhD student Mattias Nyström and research engineer Karin Nordkvist also contributed to this project, which was funded by the Swedish Environmental Protection Agency. The methods developed in these projects are currently being incorporated into nationwide mapping projects.

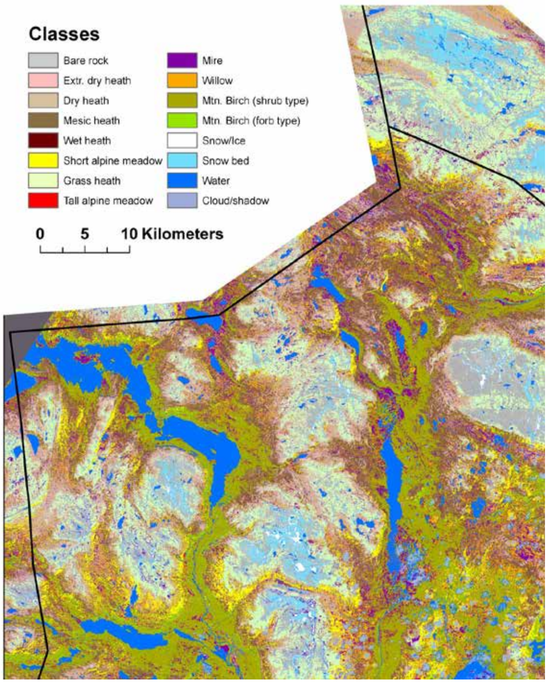


Figure 1. Classification of a combination of SPOT 5 data and a 50 m DEM data over Vindelfjällen's Nature Reserve in Västerbotten.

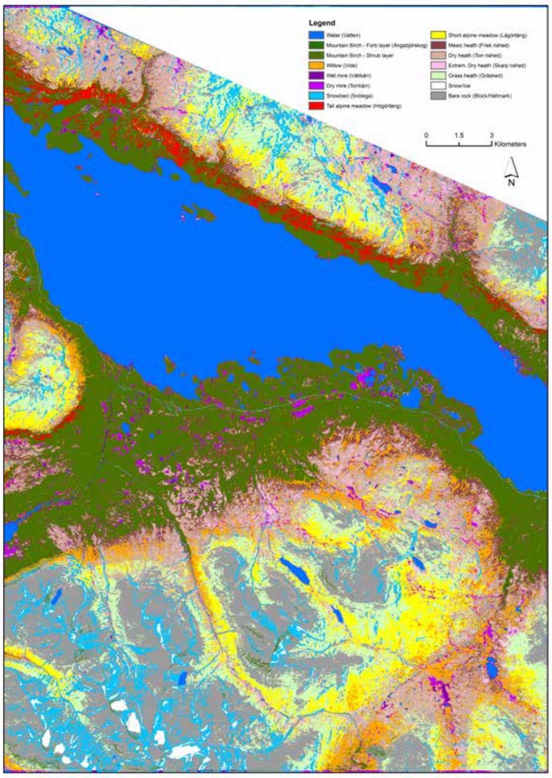


Figure 2. Classification of a combination of SPOT 5 data and 2m DEM and metrics from LiDAR point cloud over Abisko

# Forest Inventory and Empirical Ecosystem Modeling

## Historical data from the Swedish National Forest Inventory

**Data from National Forest Inventories** (NFIs) collected in Finland, Norway and Sweden since the 1920s provide valuable information for both research and environmental monitoring. The temporal depth and the unbroken continuity of the Nordic NFI datasets are unique from an international perspective. The project Historical data from the Swedish NFI focuses on data from the Swedish National Forest Inventory (Swedish NFI) that started in 1923.

**The project has three main aims**: 1. Make data and estimates from the Swedish NFI more easily accessible. 2. Transfer primary data from the two first inventory cycles into database format. 3. Perform various types of analysis based on old data or the full time series.

**The project has established a new research** infrastructure called RINFI (Research Infrastructure National Forest Inventory). The work is supported through research infrastructure funding from the Swedish Research Council VR and the Environmental Monitoring and Assessment program at SLU.

**Since 2004,** the project has cooperated with the Swedish Forest Agency and the Swedish Unemployment Agency on the entry of old data into database format. All data from the first inventory cycle, 1923–1929, is now in database format and entry of data from the second inventory cycle, 1938–1952, started in 2011. All data are expected to be in digital format by 2020.

*"Right now, the data entry is going really fast and efficiently as we have six persons working in the data entry group"*, says project leader Anna-Lena Axelsson. "We might finish earlier than expected."

Photo collage: The transfer from grazed heathlands to a Norway spruce-dominated landscape in the county of Halland during the 20th century. Photos from the SLU photo archive.

**Changes in design,** definitions and field methods are sources of possible bias in temporal comparisons. Analysis of a long time series therefore always involves harmonisation and development of analysis routines. For each variable, the lowest common denominator must be determined before analysis can be applied to the entire data set. The results of the harmonisation work form an important stepping stone for further analysis. To facilitate the harmonisation, all field manuals from 1923 to the 1990s have been scanned and will be made available as searchable PDFs through SLU's website. Anna-Lena Axelsson also leads a Nordic network for harmonisation of temporal NFI data which is financed by the Nordic Forest Research Co-operation Committee (SNS).

**In November 2012,** the project arranged the seminar "Swedish forest history in a new light" at the Royal Swedish Academy of Agriculture and Forestry in Stockholm. new products based on the entire time series from 1923 to 2010 were presented in conjunction with the seminar.

**Harmonised time series** from 1926–2008 from the Swedish NFI can now be studied using the free interactive visualising tool Sweden eXplorer. With this tool it is possible to create new analyses and share the results. Those who have seen professor Hans Rosling's amazing visualisations of global statistics know what it is all about. The data and the tool have been used in Master's level courses in forest history at the SLU forestry program at SLU in Umeå. (See www.slu.se/historiskadata/visualisering.)

*"We have also produced forest histories where old photos, maps and trend diagrams are linked through short popular texts"*, says Anna-Lena Axelsson. *"We hope that this will provide a deeper understanding of how and why the Swedish forest landscape changed during the 20th century"*. Currently there are forest histories about the darkening of the Swedish forest landscape, the reforestation of heath lands in South Sweden and the changing role of aspen in Swedish forestry. (See www.slu.se/skogshistorier.)

**The new products** were financed by information funding from the Swedish Research Council (Formas) and a grant for development of new courses in the Faculty of Forest Sciences at SLU.

**During 2013–2014** the work will focus on providing data and various products through different web solutions. The project will develop a new service but also use existing web services, research infrastructures and metadata portals to provide better and easier access to data, such as the Swedish Life Watch initiative (SLW) and the Environment and Climate Data Centre (ECDS).

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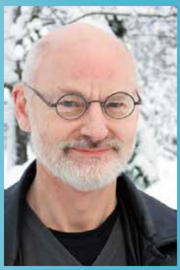
Text: Anna-Lena Axelsson
Photo collage: Mona Bonta Bergman,

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# Forest Planning

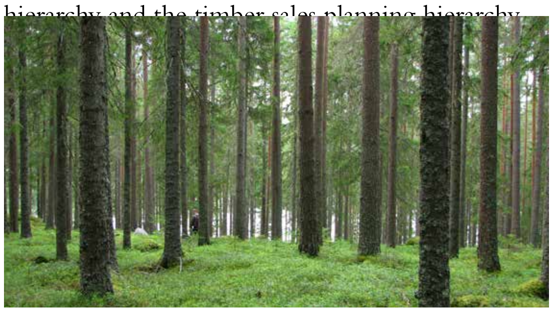
## Knowledge management in forest planning in large Swedish forest-owning companies

**Large forest-owning companies** optimise the management of the forest to sustain competitive advantage and ensure sustainability. Harvests are planned in a long and a short perspective through a hierarchical planning process in three steps: a long-term, a medium-term and a short-term plan. The long-term plan encompasses the entire forest with a focus on sustainability; the medium-term plan is concerned with allocating harvest and silvicultural operations to stands in the coming few years; and the short-term (operational) plan includes schedules for harvesting and deliveries for the coming months and weeks.

**The basic principles** for this planning process have been known and applied since the 1960s. However, the way the process has actually been followed has not been subject to further analytical and scientific study. Does one step actually fit neatly into the next (as you would guess from descriptions of company planning procedures)? We do not really know. Another reason why we need to study the planning process is technology development. New planning support systems, like those developed in remote sensing, could potentially alter the way that companies should do their plans to sustain competitive advantage.

**One approach to the mechanisms** through which the forest planning system works is to focus on the way data, information and knowledge are managed. Knowledge management (KM) theory offers a framework for studies with this focus. Among various perspectives of KM, four KM processes are defined: knowledge creation, knowledge storage/retrieval, knowledge transfer and knowledge application. KM theory also presents different strategies for how to handle knowledge within an organisation. Studies have been conducted at a Swedish forest-owning company (Sveaskog) to find out how knowledge about the forests is handled. One study followed knowledge through the first two steps of the forest planning hierarchy. New knowledge was created and stored and then transferred to the next step until the medium-term planning was finished in the TB where the stands are available to be harvested (Figure 1). One salient characteristic of the process is that many steps are required to go from the first step of the long-term plan to finalising the medium-term plan. It raises, for instance, questions concerning how knowledge could be shared (and not lost) in the process. Another feature is the hierarchical nature of planning, in which plans pass from top to bottom of the organisation, through a KM push strategy.

**Another study** with focus on the KM of information about the forests followed the forest planning hierarchy and the timber sales planning hierarchy



Well-planned forest for production. Photo: Ola Borin, SLU.

**The results show** that the knowledge in the forest planning is only one small aspect of sales planning, and that knowledge is not shared extensively between these two planning processes. There are indications that this is due to unreliable data, thus motivating better data acquisition methods, whereas other indications point to market turbulence and insufficient data on past deliveries, implying that better data will not be used anyway.

**Another study,** with focus on the link between medium-term and operational planning, highlights the different perspectives adopted by forest officers supplying forest data for operational planning and those using this data in harvesting and deliveries planning. That these perspectives differ is not surprising; however, it suggests challenges in terms of KM and organisational structure.

**The studies have so far revealed** an intricate pattern of relations among technologies, procedures and, above all, among people. The implementation of new data sources and planning systems will be far more complex than would be expected from a purely technological perspective.

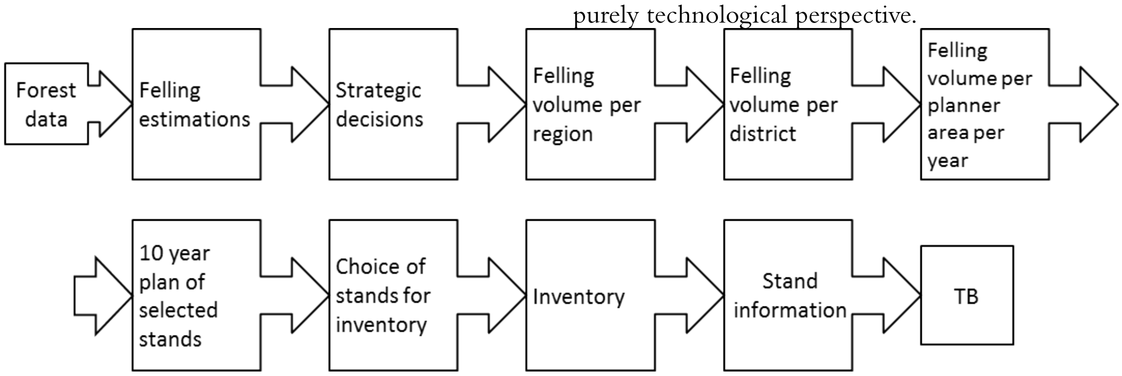



Figure 1: Knowledge processes in long- and medium-term forest planning. Illustration Maling Nilsson, SLU.

Text and Figure: Malin Nilsson., SLU
Photo: Ola Borin, SLU.

# Forest Operations Management

## Supply of forest biomass to terminals/bioenergy combines in northern Sweden

**Biomass from the forests in northern Sweden** is a natural resource that can be used for both industrial purposes and energy production. Unprocessed forest biomass has low energy density, which makes it bulky and expensive to transport. Forest biomass supply chains are therefore most economic at short distances between forest and processing facility. A development that would help develop the region of northern Sweden is to process the biomass locally and in the vicinity of the forest. Processed forest biomass is less affected by transport distance because it has higher energy density and lower moisture content than unprocessed forest biomass.

**In the two-year project** Supply of forest biomass to terminals/bioenergy combines in northern Sweden that started in December 2011 and is financed by the Swedish Energy Authority, we are first developing a methodology to reliably estimate the amount of forest biomass available around existing biomass terminals located near the forest (Figure 1). Secondly, we will investigate the conditions (cost and environmental impact) for the supply of forest biomass to the terminals. Thirdly, we will propose potential sites for the establishment of terminals where a refinement (e.g. torrefaction and pelleting) of the forest biomass could take place in order to increase its energy density. The refinement could take place in standalone facilities but also could be integrated in existing power plants/sawmills/pulpmills which then would produce heat, electricity, torrefied pellets and possibly biofuels. Many different options will be evaluated, for example, on the basis of access to forest biomass and the costs of transportation to the refinement location.

**Data from the National Forest Inventory** were used to estimate the amount of forest biomass that could be harvested in northern Sweden within a 60-year period starting from 2010. Ecological and techno-economic restrictions were applied to the harvest estimates, which diminished the amount of logging residues and stumps that can be extracted. For example, wet areas and peat soils with low bearing capacity as well as all areas located 25 meters from a lake, sea, waterline or any other ownership category than forest were not considered for the extraction of the logging residues and stumps. Sixty-five terminals were identified that could be possible locations for further refinement of the forest biomass. Terminals that were closer than10 km from each other were merged into a single terminal. The amount of biomass in different assortments (e.g., roundwood, branches and tops) around the terminals and the transportation cost to the closest terminal was calculated within service areas of 50, 50–75 and 75–100 km (Figure 2). The amount of available by-products from sawmills (e.g. sawdust, shavings and chips) in the region will also be taken into account. Each of the terminals will be evaluated according to (i) distance to existing heating plants/CHP/pulp mills/sawmills, (ii) distance to railways, (iii) distance to main roads, (iv) distance to cities bigger than 10 000 inhabitants and (v) biomass availability and cost for biomass procurement. Finally, a limited number of terminals will be chosen for the establishment of facilities for biomass refinement. An appropriate refinement will be proposed and an economic analysis based on estimations of the required capital investment and total production costs will be performed.

Figure 1. Storage of forest biomass at Stockaryd terminal in Sweden.

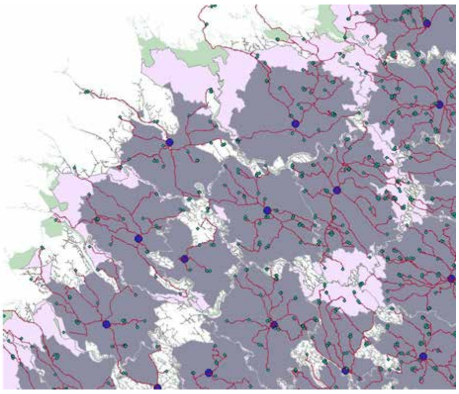


Figure 2. Service areas created around each terminal and the quickest routes from each forest inventory plot to the nearest biomass terminal.

Project leader is Dr. Dimitris Athanassiadis. Other project members in 2012 were Martin Svanberg (PhD student, Chalmers University of Technology) and Peder Wikström (Department of Forest Resource Management, SLU). PhD student Sandra Sánchez García (University of Oviedo and CETEMAS Forest and Wood Technology Research Center of Asturias) also worked on the project during her short-term scientific mission within COST Action FP0902.

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# Forest in Rural Studies

## Gender perspective on natural resource management

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**The relationship** between the use and management of natural resources and the related societal processes is a focus of our competence area. To understand human behaviour and social practices, gender as a scientific concept is of essential value. Thus, many of the ongoing projects have a gender component or gender perspective. Two of them are described here.

**In the national strategy** for gender equality in the forest sector, gender imbalance is recognised as major problem for under-represented groups, mainly women, in the workplace and as an obstacle for the development of the sector. Despite the fact that nearly 40 per cent of private forest owners are women, the male is portrayed as the subject and main knowledge possessor in the sector. For women, this creates major obstacles, limitations and difficulties in establishing their identity within forestry professions and as forest owners.

**The forming of forest owners' networks** for women is one of the various strategies that have been adopted by women to negotiate their position in the sector. Based on focus group interviews, Gun Lidestav and Elias Andersson have shown that women's forest networks constitute a vital local platform for alternative knowledge production, solidarity and resistance against inequalities. The networks are important actors in improving the competence of female forest owners by organising alternative events for discussions and knowledge exchange.

Figure 1. Networks are important in establishing women's identities as forest owners.

**Despite political attempts** to decrease gender inequalities, the situations, positions, and conditions of men's and women's lives and activities in rural areas differ. Previous research shows that men and women choose different adaption strategies to meet changing economic and social conditions. Similarly, men and women also choose to engage differently in new business activities, both within the existing farm enterprise and off-farm. The access to time, networks and resources is unequally distributed between men and women.

**The project "Doing gender (in) equality in family farming"**, funded by The Swedish Farmers' Foundation for Agricultural Research, will increase the understanding of how gender differences in family farming are reproduced. Further, the gendered aspects of distribution of resources, division of labour, life experiences and technology in Swedish family farming will be investigated. By the end of the project (spring 2014), PhD student Elias Andersson will defend a thesis in which he presents an analysis of how to monitor and understand gender inequalities in the sector and suggests measures for improvement.

Andersson's study analyses data from the Federation of Swedish Farmers to examine how material relations reproduce the gendered positions of women in Swedish agricultural sector. The aim is to develop the understanding of women's entrepreneurship, family farming and rural social relations in a Swedish context. Economic processes and material relations can be understood through analyses of the gendered access to land and its geographical, spatial and economic differences, linking material conditions to the various types and number of business activities and their ability to provide income for the household.

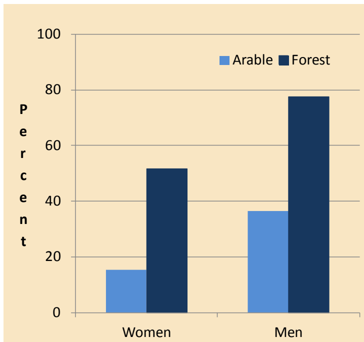


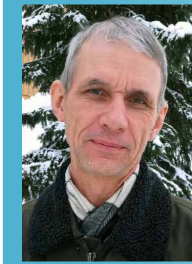

Figure 2. Average land area and gender of farm manager

**The results** of the study show an unequal distribution of arable land between farms operated by men and women. Farms operated by women control 4 per cent of the total area of arable land. The average value of a farm managed by a man is more than 2.5 times greater than that of one managed by a woman, a situation that clearly illustrates an unequal distribution of resources between men and women. Almost 60 per cent of farm households are unable to live off the farm income. However, male-operated farms are more than twice as likely to provide the main household income compared to farms operated by women. Overall, the study highlights the gendered relations between access to arable land, the farm's ability to provide income for the household, and the number and types of business activities.

Text and Figure: Elias Andersson, SLU
Photo: Patrik Umaerus, SLU

# International Forestry

## Assessing changes in tropical forest land use, its drivers and impact on society and the environment



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**Rapid forest and land use changes** such as deforestation and large-scale plantation have a strong impact on the environment, climate and livelihoods in tropical regions. Decision makers need a means to understand the driving forces behind the changes and their impacts in order to make appropriate policy decisions. An interdisciplinary approach for assessing and analysing such changes has been developed in a series of research studies at SLU, Umeå during the period 1997–2012.

**The studies**, which concerned trends in deforestation and upland agriculture in Laos and trends of increasing forest plantation by farmers in Vietnam, China and Ethiopia, have been funded by Sida, Formas and SLU and coordinated by Mats Sandewall in collaboration with PhD students from Laos (Silavanh Sawathvong), Ethiopia (Efrem Garedew, Mersha Gebrehiwot) and Sweden (Bo Ohlsson), and research staff at Wondo Genet College of Forestry, Vietnam Forestry University, the Chinese Academy of Forestry and CIFOR. (Figure 1.)

Figure 1. The rapid increase of forest plantation in Southern China was analyzed

**The approach** includes a core method, participatory field point sampling (pfps), for assessing land use trends in geographically defined landscapes, and various supportive tools for generating information that verifies the sampling data and provides further explanations of the trends. Issues include why and how farmers changed land use, how farmers are influenced by the changes and how products are used or marketed. Discussion meetings with local stakeholders and decision makers about work plans and preliminary results are important steps in the approach to generate feedback and promote a policy dialogue.

**The design** is based on a net of systematic sample points (pfps) covering the defined area. The area is defined by administrative boundaries (such as a commune) and the entire landscape is included. The distance between samples is set to achieve a certain precision. In various case studies, samples between 50 and 75 points were used and the points were located in the field using GPS or other tools.

Figure 2. Participatory field point sampling with local key informant in Vietnam

**The data recording** is made when the surveyor and the key informant (for example, an experienced farmer or an extension worker) visit the point together (Figure 2). While observing and recording the current land use, the key informant provides further data on the present, past and intended future land use. Data related to land use change, drivers of changes, and potential consequences are recorded. Historical data are collected for certain years (e.g. every fifth year) including some years when remote sensing data is available for verification of informants' memory-based data. Notes are taken on issues to be followed up in subsequent meetings with other stakeholders.

Figure 3. Meeting with farmers to discuss the outcome of pfps study in Ethiopia.

**The preliminary results** of the pfps in the form of land use trends are discussed in meetings with local stakeholders and farmers and with other researchers (Figure 3). This is important for drawing conclusions on why changes have occurred (drivers) and assessing their impacts on the local people and the environment. In an additional step, the findings are sometimes used in modeling development scenarios and bringing them to the attention of decision makers.

**In summary,** this approach combines quantitative techniques, based on statistical observations that describe actual trends, and qualitative techniques, based on interviews that explain the trends and how people understand those trends. It is participatory and illustrates how local stakeholders can be involved in policy processes.

Text and Photo: Mats Sandewall, SLU

# Environmental Monitoring and Assessment

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**The Swedish government** has given SLU the task of conducting environmental monitoring and assessment. This grants SLU a unique position among Swedish universities. SLU is collaborating closely with several public authorities to fulfil the monitoring and reporting demands that arise from national and international legislation and treaties.

**The Department** has a long tradition of working with environmental monitoring and analysis. The Swedish National Forest Inventory (NFI) started in 1923 and over time the programme has developed advanced skills in sampling theory, data management and fieldwork operations. This know-how has been used to set up and develop several other programmes or projects, many of which are described in other sections of this annual report. Currently, environmental monitoring programmes account for two-thirds of the total budget of the department.

**The information provided** by the NFI, the National Inventory of Landscapes in Sweden (NILS), the Terrestrial Habitat Monitoring (THUF) project, and other monitoring and assessment projects at the department is available to various stakeholders such as the Swedish government, national and regional public authorities, research projects, as well as private companies, NGOs and the general public. The information gathered is also used for reporting to international agreements and treaties such as the United Nations Framework Convention on Climate Change, the Convention on Long-Range Transboundary Air Pollution, the Convention on Biological Diversity, the European Habitats Directive and the Kyoto Protocol.

**The combination of research and environmental monitoring** activities is one of the strengths of the department and is leading to important synergistic effects. New technology and development in methods and models can quickly be implemented in our environmental monitoring activities. Simultaneously, data collected by our monitoring programmes provide a unique and valuable source of information for various research projects. The connection between environmental monitoring and assessment and undergraduate and master's studies is also important. It improves dissemination about environmental monitoring activities, knowledge needed for effective decision making, and sustainable use of our natural resources.

**More information**
Environmental Monitoring and Assessment, www.slu.se/en/miljoanalys

Text: Mats Nilsson, SLU
Photo: Ola Borin, SLU

# National Forest Inventory

## Forest regeneration, forest management and felling: NFI provides an invaluable resource for monitoring trends in forest management

**An important aspect** of the National Forest Inventory's role as the authority responsible for official statistics in the field of "forest status and change" is the regular analysis of forest regeneration, forest management and felling.

**During the past 25 years**, the methods used for forest regeneration have varied significantly. From the mid 1980s to the mid 1990s the general trend was an increase in natural regeneration, mainly through seed trees; however, in the mid 1990s this changed and instead moved towards an increase in seedling plantation.

**Over the period 1985–1995**, the area of young forest that underwent pre-commercial thinning decreased dramatically from about 250 000 ha to 100 000 ha per year. As a consequence of the large-scale information campaign during the late 1990s, the area of pre-commercial thinning subsequently increased again to about. 170 000 ha per year. Currently only around a fifth of the area that the Swedish NFI judges as in acute need of pre-commercial thinning is actually thinned.

**The fraction of the total felled volume** represented by commercial thinning has steadily increased from about 25% in the mid 1980s to about 30% at the end of the 2000s. Since the 1990s, first-order thinning has increased and is now the dominant form. Almost half of the thinned area is in pine stands.

**The largest harvested volume fraction** is due to final felling. The proportion that final felling represents of the total harvested volume is largest in Northern Norrland and lowest in Götaland. The annual area of final felling has remained relatively constant during the study period at about 200 000 ha. Since the early 1980s the proportion of final felling represented by deciduous trees has decreased from about 10% to about 6%.

**Final felling is dominated** by trees with a diameter 200–399 mm, and this has remained relatively unchanged during the study period. The average volume per stem in final felling, except in Northern Norrland, has increased during the period, whereas the stand age has remained stable. The proportion of final fellings with an area greater than 20 ha has decreased since the early 1990s, whereas final fellings in areas of 4–10 ha and <1 ha have increased.

**The examples** given illustrate the importance of objective and reliable data, such as that supplied by the National Forest Inventory, when monitoring and evaluating forest resource use and environmental status and change.

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

Text:Neil Cory, SLU
Photo: Ola Borin, SLU

# National Inventory of Landscapes in Sweden

## Monitoring of agricultural landscapes: an evaluation

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The programme also uses other employees within the Department´s competence areas and environmental monitoring programmes.

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

Text: Åsa Eriksson, SLU
Photo: Erik Cronvall, SLU

**Since 2006**, NILS has performed field inventories of a sample of nearly 700 meadows and pastures in Sweden on assignment from the Swedish Board of Agriculture (SBA). The objective is to detect and report changes in quality with respect to biodiversity and to contribute to the follow-up of the national environmental objectives "A Varied Agricultural Landscape" and "A Rich Diversity of Plant and Animal Life". Based on the current knowledge of measurable and reliable indicators, the inventory includes monitoring of butterflies, bumblebees, deciduous trees, epiphytic lichens and herbs, in addition to the regular set of variables in the NILS methodology.

**Several other national** or regional environmental monitoring programmes or projects, such as NILS regular inventory, the Swedish NFI, Monitoring of Terrestrial Habitats (MOTH), regional environmental monitoring based on NILS, the Swedish Bird Survey and the Swedish Butterfly Monitoring Scheme perform inventories of the agricultural landscape. The NILS meadow and pasture inventory, however, is the only national monitoring programme specifically designed for the agricultural landscape in the context of the environmental objectives mentioned above.

**In 2010,** the SBA was commissioned by the Swedish government to compile, describe and evaluate national monitoring systems with relevance to biological and cultural values in the agricultural landscape. NILS was contracted to organise and supervise part of this work generally, as well as specifically for the NILS meadow and pasture inventory, in cooperation with researchers at the Universities of Linköping and Lund, and the Swedish Biodiversity Centre CBM (at SLU). The SBA reported to the government in September 2012. The objectives were to evaluate how useful the data that are collected within ongoing monitoring programmes and projects are for follow-up of environmental objectives and evaluation of the Rural Development Programme; also to reveal whether the environmental monitoring of the agricultural landscape, in general, would benefit from a higher degree of coordination among existing monitoring programmes.

**Since NILS monitoring** of meadows and pastures was specifically designed to contribute to the SBA's reporting on the environmental objectives, it was subject to an intense evaluation, which included testing of different methods for analysis of change in environmental conditions and a detailed report of costs associated with the inventory. Monitoring programmes such as the NFI, MOTH and the Swedish Bird Survey were treated more extensively.

**The conclusions from the evaluation were:**
The national monitoring of the agricultural landscape is already well coordinated.
NILS regular inventory and the inventory of meadows and pastures, the Swedish Bird Survey, and other existing programmes are important and well suited for evaluation and measuring of environmental objectives in the agricultural landscape and should therefore continue.
It is more important to intensify analyses of already existing data from NILS and other monitoring programmes than to enforce changes, such as additions of variables on top of the current inventory protocols in existing monitoring programmes or to develop new programmes.
Monitoring of biodiversity in arable land is insufficient and should be improved.
For an evaluation of the Rural Development Programme, it is necessary to combine data from different sources, such as regional and national monitoring programmes and directed inventories of rare habitats.

**An important result** of the project is that the SBA from 2013 onwards will increase the funding of NILS monitoring of meadows and pastures to ensure that quality and quantity of data and analyses are maintained and enhanced.

# Terrestrial Habitat Monitoring

**Monitoring of Terrestrial Habitats (MOTH)** is a collaboration project between SLU and the Swedish Environmental Protection Agency (SEPA). The project was initiated as a response to the growing demands of information from habitats and species with a high conservation value – information needed in the on-going process of implementing the EU Habitats Directive. The objective of the project is to develop and demonstrate a functional monitoring programme that on a national level will deliver accurate estimates of areal coverage, distribution and conservation status of terrestrial habitats listed in Annex I of the Habitats Directive.

**The Swedish National Forest Inventory (NFI) and National Inventory of Landscapes in Sweden (NILS)** are two on-going programmes at the Department that already collects data on coverage and status of terrestrial habitats. MOTH will use, compile and validate this information. Assessment and experiences from the last reporting shows that the Swedish NFI and NILS are able to deliver accurate data from common habitats. However, for less abundant habitat types the precision are too low to fulfil the requirements needed and we have developed new sampling protocols that specifically targets sparse terrestrial habitats with high conservation values. The two new inventories are both based on two-phase sampling designs that combines a first sampling phase using remote sensing with a second phase with field data collection.

**The first inventory** is called the point-grid inventory and the sampling protocol covers all regions in Sweden. The sampling unit is a landscape plot with a size of 5.0×2.2 km2. 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 base-line survey of Natura 2000 sites. From each habitat group, we then randomly select points to be included in a set of field points. These are surveyed and a number of variables are recorded, such as habitat, land use, vegetation and other variables that can be used for determining the conservation status. The field assessment is conducted in collaboration with the NILS programme. In September 2012 we finished the third season of data collection. In total 377 plots distributed all over Sweden with a total of 73605 grid points have been surveyed manually by remote sensing. A random selection of 4107 of these plots have later been visited, habitat classified and surveyed by our field teams.

**The second inventory,** the sea-shore habitat inventory, is focused on the terrestrial parts of the marine shores. The survey is based on 250 sample units (5 x 2.5 km), randomly placed along the Swedish coast-line. Over an aerial photo of each sample unit, a hexagonal grid is laid. A photo interpreter scrutinizes every intersection between grid and shoreline, and makes a rough classification of the habitat based on substrate, vegetation, degree of exploitation etc. Points likely to present interesting habitat types are selected for field survey.

**At each selected point**, field workers place a 10 m wide transect across the shore. Habitats are classified, and variables such as land use, plant species and marine debris are noted. When the data from all points is compiled, the total area of shore habitats can be calculated and their overall conservation status assessed. The project has finished the first season of the sea-shore inventory. 50 sampling units with 3550 shore transects were surveyed using remote sensing. Of these, 231 was randomly selected and visited in the field.

**During the autumn 2012** the project started the compilation and analyses of all habitat data available from MOTH, NILS and the Swedish NFI from the period 2008 to 2012. This information will be submitted and used in the assessment Habitats Directive during 2013.

**Results** from the project have been presented at several national as well as international workshops including; 'Miljöövervakningsdagarna' in Ronneby , September 19-20, at a Biogeographic monitoring meeting with the Czech EPA, Swedish EPA, SLU at September 24, 2012 in Uppsala, and at a workshop with the French NFI at September 11 in Umeå.

**MOTH is a Life+** project financed by the European Commission, SEPA 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 June 2014. The total budget is 4.8 million Euros. More information is available at the project home page http://www.slu.se/moth.

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

Text and photo: Hans Gardfjell, SLU

# Forest Sustainability Analysis

## SHa Performs Long-Term Analysis of the Forest Ecosystem´s Potential to Produce Goods and Services

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The programme 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: Tomas Lämås
Photo: Tomas Lämås, SLU and Sofia Hansson, SLU

**The programme Forest Sustainability Analysis** (SHa) was established in 2011 as a significant complement to the environmental monitoring programmes run by the Department. When managing a natural resource such monitoring programmes are invaluable to following up the development of the resource. Equally important, though, is the analyses of future development of the resource given different scenarios. This can help avoid undesired consequences and allow preferred alternatives to be sought. The aim of SHa is to provide competence, decision support tools and ana-lyses related to forest resource development – including the production of goods and services – to policy developers, decision makers and managers within sectors such as forestry, environment and energy.

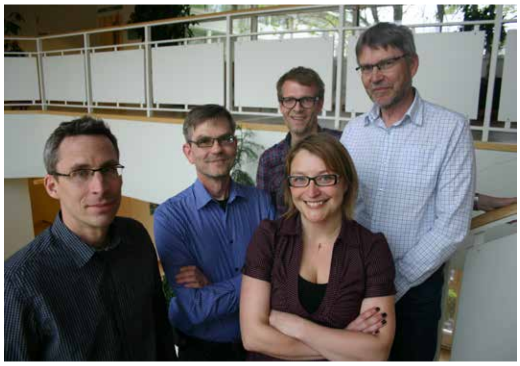
**Projections of forest resource** development and the corresponding production of goods and services make up the base for SHa forest scenario analyses as well as for management planning. The main focus for SHa is to perform analyses of goods and services closely related to the central part of above projections; development of trees and stands, such as timber and bio-fuel production, carbon sequestration, recreation potential and habitat availability. However, in collaboration with other disciplines and research areas, aspects such as water quality and soil factors can also be explored.

**SHa concerns all of the competence areas** and environmental monitoring programmes at the Department and the programme is organizationally placed directly under the Head of the Department. The location at the Department secures core competence in computerized analyses and planning systems as well as competence within modeling, forest inventory, management planning, remote sensing and environmental monitoring and assessment.

**The newly developed Heureka system** is a central technical platform for the SHa activities. The system, personnel and competence make up an infrastructure for education, research, environmental monitoring and assessment, and other commissions related to sustainability analysis. The Heureka system being a central tool does, however, not exclude other potential tools.

**Financed by SLU**, the Kempe Foundations, the Forest Industries Federation and the Foundation for Strategic Environmental Research, the Heureka system was developed between 2000-2009 involving a number of departments at SLU and also the Forestry Research Institute of Sweden. SHa is now responsible for the maintenance and development of the system. The Heureka system is used in education and research and it is under introduction at forest companies and other organizations. Year 2011 saw a number of milestones for Heureka. SHa perform-ed introductory courses at forest companies and organizations and the first openly announced basic course was given by SHa personnel at the Forestry Research Institute of Sweden. The first large-scale long-term planning at a forest company was performed as Bergvik Skog AB elaborated plans for their 1.8 million ha forest area. In 2011, three scientific papers in different scientific disciplines were published in which the Heureka system was used. A forth published scientific paper was an overview of the Heureka system itself. The system is regularly used in two undergraduate courses and in 2011 four Master´s theses were published all of which contained Heureka analyses.

**SHa both initiates** research and development projects and takes part in projects initiated by others. For example, in collaboration with the research programme Future Forests at SLU, SHa elaborated landscape scenarios for the Sveaskog "growth park" Strömsjöliden. At Strömsjöliden, Sveaskog studies the potential for a drastically increased timber and bio-fuel production in collaboration with SLU. In the project such a scenario as well as alternative, contrasting scenarios were analysed (Figure 1). The scenarios were used in cross-disciplinary discussions within the research programme. Moreover, in 2011 two EU FP7 projects that will be associated to SHa were granted funding, INTEGRAL which concerns policy process on the one hand and local management on the other, and ARANGE which concerns forest management in mountain areas.



Medarbetare i SHa 2012, från vänster Peder Wikström, systemansvarig, Tomas Lämås, programledare, Hampus Holmström, analytiker, Mona Bonta Bergman, kommunikatör, Anders Lundström, analytiker.

# Environmental Management System

## Integration of the Department’s Goals and Environmental Goals

**During 2012** the department continued its work with the integration of the departments’ objectives and strategies in the environmental management system. Both the internal as well as the external auditor for the management system praised the department for our focus on our environmental work and how we use the management system as a tool to obtain our objectives. To contain our environmental influence by traveling a travel policy was adopted. This policy encourages us to use telepresence meetings or life-contacts via internet whenever possible, and to prefer environmental friendly travel alternatives over flying whenever feasible when a personal meeting is envisaged. Every year a course about the environmental management system is organized for those that are newly employed by the department. This year the course was held in English and attended by five participants.

Dianne Staal Wästerlund
Co-ordinator

Text: Dianne Staal Wästerlund, SLU
Photo: Viktor Wrange, SLU

# Publications

The publication list below includes work that was published during 2012. The publications are presented for each of the Department´s competence areas and environmental monitoring programmes separately. Peer reviewed scientific articles are listed first followed by book chapters, proceedings and reports. In the end of the publication list, articles in popular science and in press are listed.

## Remote Sensing

### Scientific Articles


- Bohlin J., Wallerman J. and Fransson J.E.S. 2012. Forest variable estimation using photogrammetric matching of digital aerial images in combination with a high-resolution DEM. Scandinavian Journal of Forest Research, vol. 27, no. 7, pp. 692-699.
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- Nyström M., Holmgren J. and Olsson H. 2012. Prediction of tree biomass in the forest–tundra ecotone using airborne laser scanning. Remote Sensing of Environment, vol. 123, no. 1, pp. 271-279.
- Santoro M., Pantze A., Fransson J.E.S., Dahlgren J. and Persson A. 2012. Nation-wide clear-cut mapping in Sweden using ALOS PALSAR strip images. Remote Sensing, vol. 4, no. 6, pp. 1693-1715.
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- Montaghi A., Egberth M., Wallerman J., Nilsson M. and Olsson H. 2012. Analysis of effects of scanning angle on ALS-derived vegetation metrics in a nationwide airborne ALS acquisition. In Proc. SilviLaser 2012, Vancover, Canada, 16-19 September.
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- Duncker P. S., Barreiro S. M., Hengeveld G. M., Lind T., Mason W. L., Ambrozy S. and Spiecker H. 2012. Classification of forest management approaches: a new conceptual framework and its applicability to European forestry. Ecology and Society, vol. 17, no. 4, pp. 51-67.
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- Grafström A., Qualité L., Tillé Y. and Matei A. 2012. Size constrained unequal probability sampling with a non-integer sum of inclusion probabilities. Electronic Journal of Statistics, vol. 6, no. 1, pp. 1477-1489.
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- Ramezani H. 2012. A note on the normalized definition of shannon´s diversity index in landscape pattern analysis. Environmental and natural resources research, vol. 2, no. 4, pp. 54-60.
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- Lundblad M., Karltun E. and Petersson H. 2012. Land Use, Land-Use Change and Forestry (CRF sector 5). In National Inventory Report 2012 Sweden - submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, pp. 268-300.

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- Eriksson L.O., Gustavsson L., Hänninen R., Kallio M., Lyhykäinen H., Pingoud K., Pohjola J., Sathre R., Solberg B. and Svanaes J. 2012. Climate change mitigation through increased wood use in the European construction sector—towards an integrated modelling framework. European Journal of Forest Research, vol. 131, no. 1, pp. 131-144.
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- Kronholm T. and Staal Wästerlund D. 2012. District council members and the organizational renewal of forest owners' associations. In Proc. IUFRO 3.08.00 Small-Scale Forestry Conference 2012: Science for Solutions, Amherst, Massachusetts, 24-27 September, 2012.

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- Öhman K., Holmström H., Nordström E-M. and Sandström C. 2012. Arbetsmodell för skogliga scenarioanalyser och foderprognoser för ett älgförvaltningsområde. Arbetsrapport, Sveriges lantbruksuniversitet, Institutionen för skoglig resurshushållning, vol. 347.

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- Berg S., Bergström D., Athanassiadis D. and Nordfjell T. 2012. Torque required to twist and cut loose Scots pine stumps. Scandinavian Journal of Forest Research, vol. 27, no. 8, pp. 724-733.
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logs in mechanized cut-to-length harvesting. Forest Science, vol. 58, no. 4, pp. 326-341.

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### Proceedings

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- Berg S. 2012. Analysis of environmentally friendly harvesting system for integrated stump fuel and round wood production. In Proc. World Bioenergy 2012: Confereence & Exhibition on Biomass and Energy, Jönköping, Sweden, 29-31 May, 2012.
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- Ersson B.T., Jundén L., Bergsten U. and Servin M. 2012. Simulations of mechanized planting - modelling terrain and crane-mounted planting devices. In Proc. Nordic Baltic conference on forest operations – OSCAR 2012, Riga, Latvia, 24-26 October, 2012.
- Fjeld D. 2012. Discrete-event simulation of collaboration between transport organizations In Proc. Nordic Baltic conference on forest operations – OSCAR 2012, Riga, Latvia, 24-26 October, 2012.
- Fjeld D. 2012. Simulation the effect of fleet management routines on delivery precision and truck utilization. In Proc. Nordic Baltic conference on forest operations – OSCAR 2012, Riga, Latvia, 24-26 October, 2012.
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# National Forest Inventory

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- Poudel Chandra B., Sathre R., Bergh J., Gustafsson L., Lundström A. and Hyvönen R. 2012. Potential effects of intensive forestry on biomass production and total carbon balance in north-central. Sweden Environmental Science & Policy, vol. 15, no. 1, pp. 106-124.

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# National Inventory of Landscapes in Sweden

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# 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

Marcus Ander
Emma Andersson
Leif Andersson
Lars Bengtsson
Johan Bergstedt
Tommy Bohman
Ola Borin
Åke Bruhn
Stefan Callmer
Fiona Campbell
Bert Carlström
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Hans Davidsson
Lars Davidsson
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Christofer Engberg Hydén
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Bo Hansson
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Nanna Håkansson
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Mats Jonasson
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Susanne Söderberg
Ola Tjernberg
Karl Walheim
Jonas Vesterlund
Sofia Vestin
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Hailu Zelleke

## National Inventory of Landscapes in Sweden

Crister Albinsson
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Isabelle Eriksson
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Peter Nielsen
Jenny Olsson
Anna-Karin Persson
Kristina Pettersson
Karolin Ring
Emma Sandler Berlin
Martin Schmalholz
Albert Tunér
Ulrika Westling
Karin Wikström

# In Memory of

**Bengt Jonsson, Professor at the Collage of Forestry passed away at the age of 83.**

OBITUARY
Bengt graduated with a Master of Science in Forestry (jägmästarexamen) in 1955. His curiosity for the mysteries of the natural world led him directly into the field of research; and it was there he remained. He did not take the easy path; he chose to focus on the fundamental questions. He developed our knowledge and understanding of how trees grow, and from this how stands and whole forests grow, on different kinds of soils and in different climates. In his doctoral thesis from 1969 he demonstrated how the tree rings of conifers varied with the weather. Such work became an important basis for further studies in such topical issues as soil acidification and climate change. During his research and even right until the end Bengt could be found during the height of summer auditing his study areas. It was hard to find the staff, but his wife Birgitta always volunteered. She now looks back on all those summers with both joy and sadness. An unusual choice of a holiday for a dentist, some thought. Bengt had a close relationship with the forest sector though his collaborations with different stakeholders and institutions. There was a constant need for expert knowledge about standing volumes, increment, the effects of different management practices and ultimately sustainable forestry. Methods were available but they were often uncertain and time consuming. Bengt and his co-workers developed a "package" of computer based programs and resources. These made forest and forestry predictions quicker and more reliable. Practical problem of course arose. Bengt also showed he was a skilled craftsman and inventor. The digital calliper was one of these inventions. His forest forecasting package is now used in nearly half of the country's forest land. Bengt was an inspirational teacher. Many students who had already passed his courses could be often found listening to his lectures again. His enthusiasm and dashing humour was a pleasure to witness. He was elected and served as the student unions mentor for 15 years. Bengt was a gifted singer. There were many a dinner and anniversary where the glorious tones of the student unions mentor and other likeminded could be heard. Of course there were also the obligatory puns and jokes as well. Bengt Jonsson sat on the board of the Royal Swedish Academy of Agriculture and Forestry. His was awarded numerous awards from both local and national associations.
His large circle of friends will sorely miss the warmth and joy he always spread amongst those around him. His is most closely mourned by his wife Birgitta and children Marina, Anette and Tor and their families; but also by many dear friends within the Swedish forest community.

Henning Hamilton Sören Holm
Ola Lindgren Göran Ståhl

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**Our dear friend and colleague Nelson Sherman died suddenly and unexpectedly on July 7, 2012.**

Nelson came to SLU in 2010 with his substantial background in programming to work on the HistTax project. The HistTax project involves the input of historical data from the National Forest Inventory and has an important role for future analyses. Nelson's work was noted as being very accurate and thoughtfully detailed so that when we now take up where Nelson left off, we have a well-laid path that he prepared. Many at the Department remember Nelson as a happy, positive and social person and it is with great regret that he is no longer with us. We enjoyed many lively discussions around the coffee table during "fika". In addition, during lunches we learned about Nelson's remarkable life which had roots in Virginia, US, and his life over the past 40 years in Sweden. We also had good opportunities to discuss other topics Nelson enjoyed philosophizing about: language, programming, and science fiction books and films. During his time here, we got to meet his lovely wife Eva, and hear about their two children. He is sorely missed. The Department has honored his memory by giving a gift of trees in the VI-woods.

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