Department of Forest Resource Management

Annual Report 2010

Johan Fransson
Head of Department

Dear Reader,

With pleasure, I invite you hereby to take part of the Department's activities carried out during 2010. 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. Time flies and another year has passed and we try to sum up our efforts and what we have accomplished in this annual report. Our visions, goals and strategies have in some way, thereby, been transformed into a historic archive!

The year begins with that Tomas Lundmark entering as the new Dean to set the overall agenda for the activities at the Faculty of Forest Sciences. The Department continues to expand, which is reflected in that a new fifth section is formed, the Section of Landscape Analysis - opening ceremony takes place with much excitement in January. At the same time we celebrate the kick-off of the Life+ project MOTH, with the overall objective to develop and demonstrate a fully functional monitoring programme to support the reporting required by the EU's Habitats directive. In March, an important scientific article is published online describing the environmental monitoring programme, National Inventory of Landscapes in Sweden (NILS), in terms of scope, design and experiences from establishing a multiscale biodiversity monitoring system. The red carpet is rolled out in April when our Vice-Chancellor Lisa Sennerby Forsse together with Deputy Vice-Chancellor Lena Andersson-Eklund visited the Department. It gave us an excellent opportunity to show our activities and have a good dialogue about future challenges.

As in previous years the field season begins in late spring. Our field operations are now very substantial and form a complex part of the activities of several different surveys (National Forest Inventory – NFI, NILS and Terrestrial Habitat Monitoring among others), funders and stakeholders. This year, the inventories turned out especially well thanks to our highly motivated and skilled field workers in combination with large efforts in preparing and managing the field work together with nice and sunny weather!

In October, an important decision is taken to launch the NFI´s new data collection system for the field season of 2011. Also this month, our environmental management system passes without remarks in an external revision to be valid for another three years. In this annual report, we have as a novelty introduced a page describing our activities of environmental management at the Department. In December it was time to round off the year by eating a nice Christmas lunch at Skeppsvik´s manor house, where we traveled in an environmentally sound manner by renting two large buses.

Moreover, the Department has actively contributed to a number of conferences, government mandates, international reporting (e.g. Forest Europe, UNFCCC, Kyoto Protocol) and was represented in a side-event at the climate meeting in Cancún, Mexico. We also arranged and hosted the European Biodiversity Observation Network (EBONE) project meeting and Advisory Board meeting in Västerås. In addition, 23 Master's theses and three doctoral theses were completed! During the year, the Department employed 20 new staff persons and 8 people retired or sought new jobs outside the Department.

In the pages that follow you will find some of the highlights from 2010. For further reading I recommend you to take a deep dive into the Master's thesis reports and doctoral thesis as well as the publications listed at the end of this annual report. I would also encourage you to visit our new homepage at www.slu.se/srh.

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 2010:

- Karin Öhman was appointed as Deputy Head
- Håkan Olsson was appointed as Head of the Section of Forest Remote Sensing
- Johan Svensson was appointed as Head of the Section of Landscape Analysis
- Sören Holm was given the Royal Swedish Academy of Agriculture and Forestry's award of "exemplary efforts in forestry and agricultural research services" from his Majesty the King
- Barbro Gunnarsson retired from the Unit of Administration after over 40 years of employment at SLU
- Linda Ågren was employed at the Unit of Administration as Economist with specialisation in EU contracts
- Bo Eriksson retired from the Section of Forest Resource Data after 35 years of employment at SLU
- Mats Nilsson earned the competence of Associate Professor (Docent) in Forest Management with focus on Remote Sensing
- Mona Bonta Bergman was contracted to work part time with information and communication (while Sofia Hansson was on parental leave)
- Hans Gardfjell was appointed as Acting Vice Head of Environmental Monitoring and Assessment (while Mats Nilsson was on parental leave)
- Härje Bååth retired from the Section of Forest Resource Data after 37 years of employment at SLU
- Anton Grafström was employed as Assistant Professor in Forest Inventory
- Anders Pålsson was honoured in a special celebration for employees that have served the government (SLU) 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!

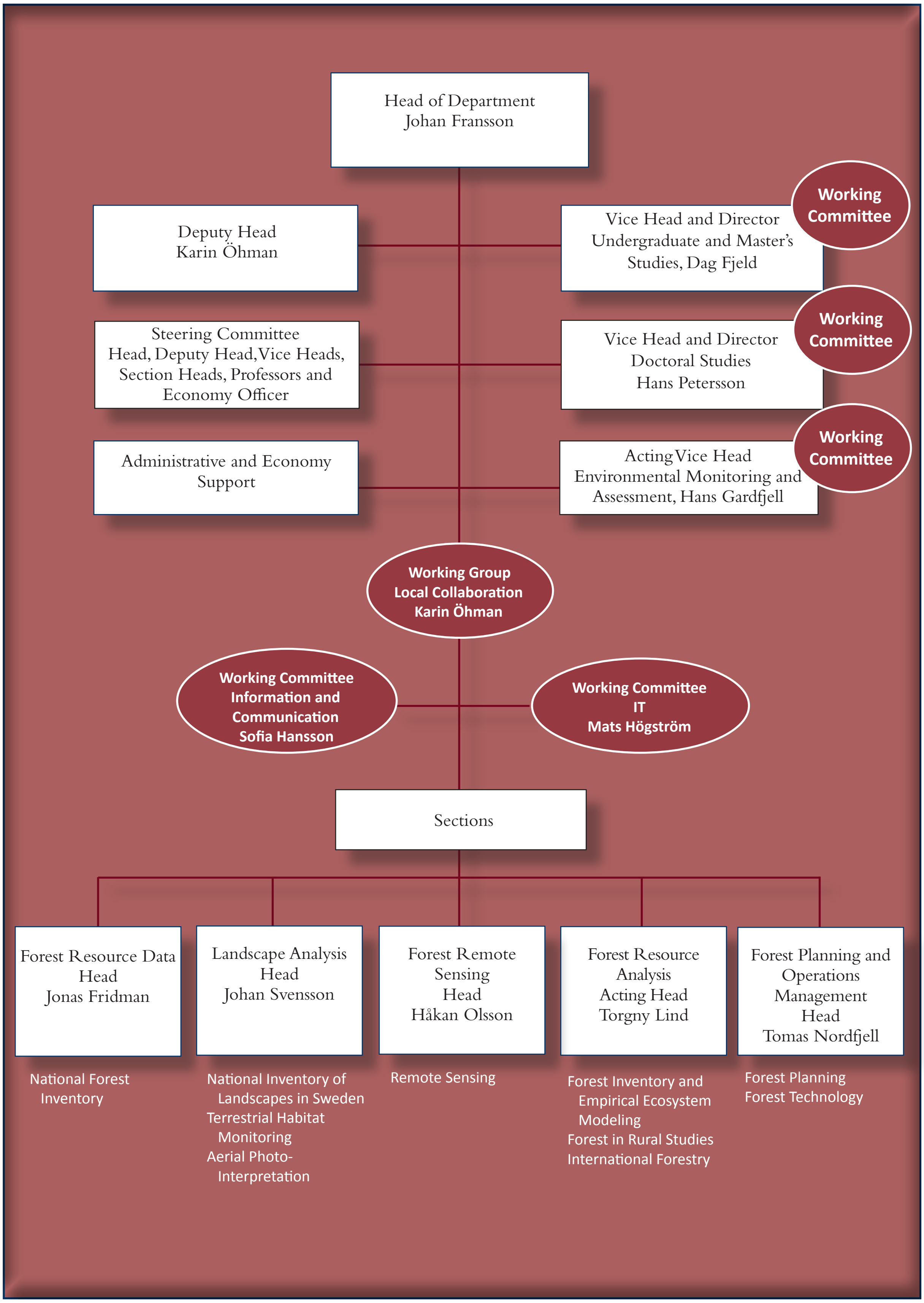
Yours sincerely,
Johan Fransson
Head of Department

Contents

Cover: Åsa Gallegos Torell
Publisher: Johan Fransson
Editors Sofia Hansson and Mona Bonta Bergman
Layout: Sofia Hansson and Mona Bonta Bergman

Organization

Schematic View of the Department

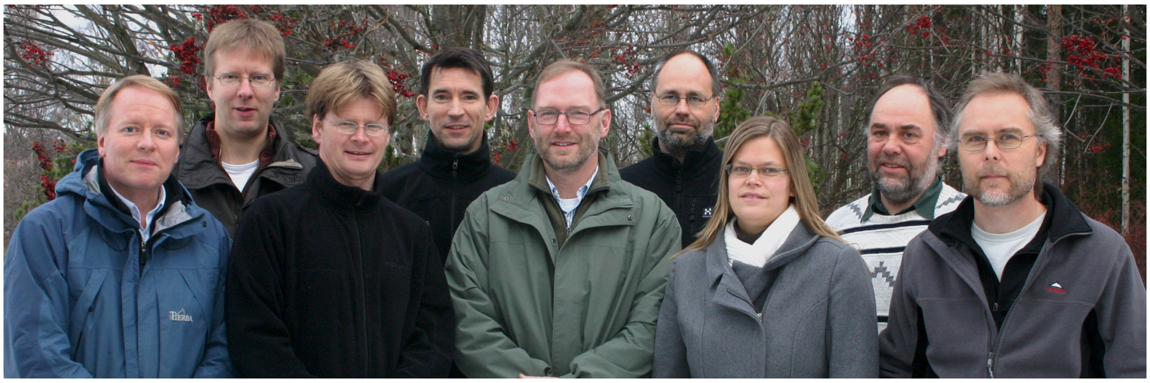


Text and figure:
Sofia Hansson and
Mona Bonta Bergman

From the left:
Johan Fransson
Torgny Lind
Hans Petersson
Jonas Fridman
Dag Fjeld
Hans Gardfjell
Karin Öhman
Tomas Nordfjell
Johan Svensson

Missing from the picture:
Maud Andersson
Anna-Lena Axelsson
Ola Eriksson
Mats Nilsson
Håkan Olsson
Göran Ståhl
Iwan Wästerlund

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 2010.

From the left:
Maud Andersson, Economy Officer
Ylva Jonsson, Economy Administrator
Linda Ågren, Economist
Anne-Maj Jonsson, Economy Officer

Missing from the picture:
Barbro Gunnarsson, Administrator
Sofia Hansson, Information Officer
Carina Westerlund, Administrator

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.

Picture of the employees at the Department 2010

On 13th of October the staff gathered for a Department day in the nearby city of Örnsköldsvik to discuss this year's theme: Publishing and Documenting. The staff received an inspiring seminar from former Dean Jan-Erik Hällgren. Taking the ropeway to the top of the mountain Varvsberget, we all enjoyed a delicious lunch with a splendid view over the city. Group discussions followed and the content of these discussions will be the foundation for a revised strategy on publishing.

Pictures: Mona Bonta Bergman

Press Clippings

Cartographic and GIT conference 2010

A report by Göran Malm about the "Kartdagar och GIT-mässa 2010" is included in the "Kart & Bildteknik" journal 2010:2. Among other lectures a speech from SLU was mentioned. The journal reported how Eva Lindberg from the Section of Forest Remote Sensing, explained the possibility to identify multi-layered forests using full waveform data from laserscanning. The journal further reports that information about small trees and undergrowth can be derived using this type of dataset.

Kart & Bildteknik, Mapping and Image Science, Kartografiska sällskapet/ Swedish Cartographic Society, no. 2

"The Swedish parliament earmarks 8 million kronor to continue work with reindeer husbandry plans"

To improve the communication about their land use needs, Sami reindeer herding communities produce reindeer husbandry plans with assistance from the Swedish Forest Agency and SLU. The continuation of this work is now secured through additional funds for 2011-2014. "Communication through reindeer husbandry plans" reduces the risk of conflicts between reindeer herders and foresters" says the Swedish minister of Agriculture Eskil Erlandsson.

On SR (Swedish Radio), 8th September

"Academy award for exemplary efforts in forestry and agricultural research services"

From the Foundation of Hugo and Emma Björkman´s memorial fund, University lecturer Sören Holm, at the Swedish University of Agricultural Sciences, is awarded with a prize for his unselfish statistical efforts for many researchers during a long period. Holm has made tremendous efforts in terms of statistical assistance to colleagues during decades, mainly at SLU, and many times other scientists have been put in the foreground and reaped the benefits of his elegant calculations.

More information: http://www.ksla.se/sv/retrieve_file.asp?n=2234

"Is Besten the best?"

"The Besten system with a pilotless harvester and two forwarders creates too much waiting time. Therefore it has no future in forestry" concluded Ola Lindroos. The Besten system was seen as a competitor to the ordinary harvester-forwarder system in final felling. But Ola's theoretical analysis showed that the expected time savings of direct loading is far from guaranteed, waiting time is dependent on the site conditions and the technical utilisation is much lower compared to the independent machines. "The Besten system is simply too hot to have a future in forestry" according to Ola.

Skogen, no. 2

Monitoring of bumblebees and butterflies

The annual education of field workers in the National Inventory of Landscapes in Sweden takes place in Mullsjö. Thirty-one field workers, most of them experienced biologists, are trained in vegetation cover estimation and species identification, in a variety of habitats in the vicinity of Mullsjö, in the south of Sweden. After education, inventory teams collect data across the country, for follow-up of the national environmental objectives. At the NILS office, situated at the Swedish University of Agricultural Sciences in Umeå, additional data from the same plots are collected by aerial photo interpretation.

Jönköpingsposten, May

"Forest commons in boreal Sweden – a successful fairy tale?"

In december 2009 Eva Holmgren defended her doctoral thesis at SLU in Umeå. The subject was forest commons in boreal Sweden. The forest commons included in the study were Älvdalen and Tärna-Stensele in Västerbotten and Jokkmokk, in Norrbotten. You can read about some of her results in *Fakta Skog - rön från Sveriges lantbruksuniversitet, no. 1.*

http://www.slu.se/PageFiles/33707/2010/FaktaSkog_01_2010.pdf

"More dead wood in the forests"

The volume of dead wood continues to increase in Swedish forests. Statistics from the National Forest Inventory show an increase of about 25% since the middle of the 1990's. Even the total standing volume has continued to increase and is now more than 3100 million cubic meters. This increase is mainly due to increases in the standing volume of pine and broadleaves. Annual growth maintains a high level at 121 million cubic meters per year.

Dagens Nyheter, 27th September

"Heureka out on new tracks"

Tomas Lämås can after eight years as programme manager tick off many objectives that were achieved by the Heureka research programme, and more is underway. A management unit has been created to assure the system´s continued existence and availability. Projects that deal with climate change, biodiversity and forest production are using the Heureka system, which is known internationally. "We have seen people from other countries downloading and using the Heureka system. There is nothing else like this system" says Tomas Lämås who will now take a short breather.

Mistra Nyhetsbrev, no. 2

"Certification improves the economy"

Private forest owner with a certified property are more active than those with a non-certified property. One third of the forest owners consider certification to give a positive economic effect. Only a few forest owners find certification to be negative in economical terms. These are some of the result from an analysis performed by Solveig Berg Lejon and Gun Lidestav at the Swedish University of Agricultural Sciences. Forest certification is most popular in the southern part of Sweden.

Skogen, no. 6-7

"More damage in Lodgepole pine than native Scots pine"

Lodgepole pine produces on average 39% more volume than our native Scots pine of similar age and on comparable land. However, Lodgepole pine suffers more damage than our native pine, primarily stem failure, but even a greater degree of damage resulting in a negative effect on timber quality explains Neil Cory, SLU. He is the author of this years themed chapter in Skogsdata (the annual publication from the Swedish National Forest Inventory). Large scale planting of Lodgepole pine started 40 years ago in Sweden and today there are ca 475 000 hectares of Lodgepole pine forest in the country, primarily in northern Sweden.

Skogsaktuellt, 23th September

"Campaign reveals how forest change can be monitored from space"

The website of ESA, the living planet programme reports: "The BioSAR 2010 campaign is the third of its kind, building on two similar experiments to show how spaceborne radar can map stocks of boreal forest". The campaign took place over the Remningstorp forest test site in southern Sweden in October.

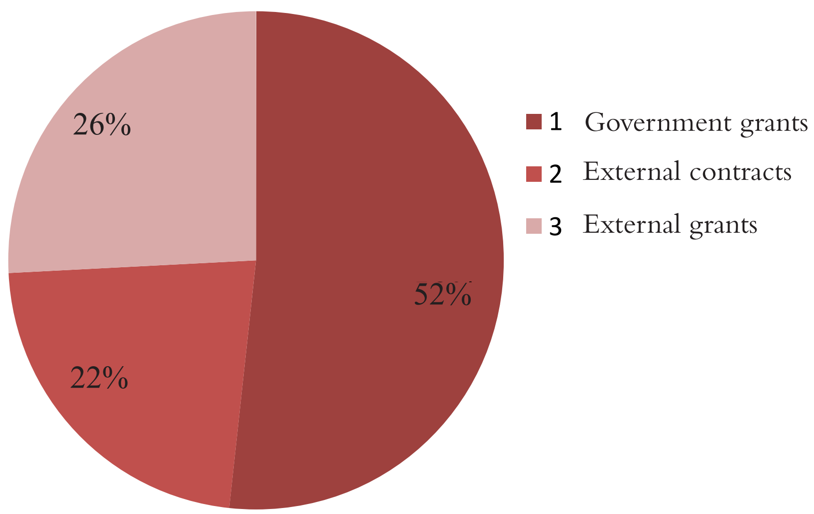
Accessed 26th October:
http://www.esa.int/esaLP/SEMJBT1PLFG_index_0.html

Facts and Figures

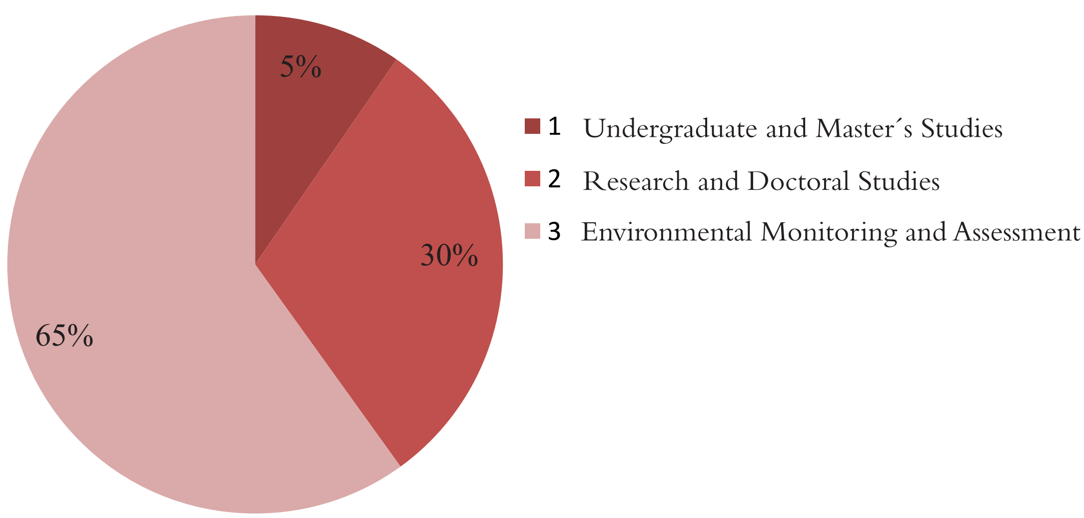
Revenues (1000 SEK)	Undergraduate and Master´s Studies	Research and Doctoral Studies	Environmental Monitoring and Assessment	Support Function	Total
Government grants	6 641	21 057	41 403	0	69 101
External contracts	364	2 332	27 085	221	30 001
External grants	0	16 506	17 962	19	34 487
Other revenues	5	51	37	5	97
Total	**7 010**	**39 946**	**86 487**	**245**	**133 686**

Costs (1000 SEK)					
Staff	3 998	21 699	47 820	4 898	78 415
Premises	534	1 316	1 497	2 087	5 434
Other operative expenses	477	8 181	22 683	2 774	34 115
Depreciation	28	36	573	30	667
Overheads	1 362	7 214	13 599	-8 435	13 740
Total	**6 399**	**38 446**	**86 172**	**1 354**	**132 371**

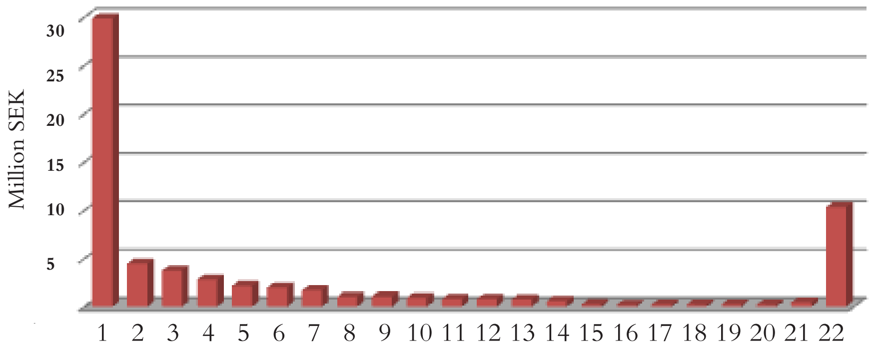
Revenues



Costs



External Contracts and Grants



	Financier	Incomings (million SEK)
1	Swedish Environmental Protection Agency	29.9
2	Formas	4.5
3	Swedish Board of Agriculture	3.7
4	Swedish National Space Agency	2.8
5	EU	2.1
6	Swedish Forest Society Foundation	2.0
7	Swedish Energy Agency	1.7
8	Swedish Research Council	1.0
9	Brattås Foundation	1.0
10	KSLA	0.9
11	Swedish Forest Research Institute	0.8
12	KK Foundation	0.8
13	The Swedish Farmers' Foundation	0.8
14	Swedish Forest Agency	0.6
15	Swedish National Heritage Board	0.3
16	Kempe Foundations	0.2
17	SIDA	0.2
18	County Administrative Board in Stockholm	0.2
19	IVL Swedish Environmental Research Institute	0.2
20	Rönnberg´s Foundation	0.2
21	Wage subsidies	0.4
22	Other, accruals	10.3
	Total	**64.6**

Personnel Categories	Number of Work-Years*
Professors	4.5
Associate Professors/University lecturers	10.2
Assistent Professor	1.0
Researchers	16.8
Post doctoral students	4.5
Doctoral students	22.3
Other teachers	1.6
Administrative staff	4.6
Technical staff	39.2
Technical staff (field)	40.0
Total staff	**144.7**

*These figures show the number of work-years at the Department, and is not a true reflection of the number of employees.

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

Undergraduate and Master's Studies

The Department is a major contributor to SLU´s Master of Forestry Programme (Jägmästarutbildningen). The Department is also active in contract education for forest companies and international co-operation with other universities. Our course selection in the Master of Forestry Programme amounts to over 40 ECTS credits at the undergraduate level and 80 ECTS credits at the Master´s level. The courses are given within six subjects: Remote Sensing and Geographic Information Technology (GIT), Forest Inventory, Forest Planning, Forest Technology and Wood Supply and Organization and Leadership.

In 2010, the first international Master´s programme Environmental Monitoring and Assessment was initiated at the Department. The programme is a co-operation between the departments of Forest Resource Management, Wildlife, Fish and Environmental Studies and Forest Economics, where Dr Torgny Lind at the Department is the co-ordinator.

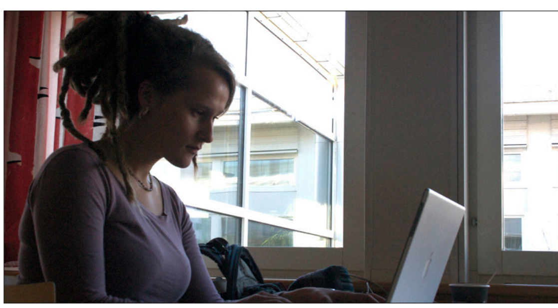
Subject co-ordinators. Curriculum development is handled by subject co-ordinators: Jonas Bohlin (Remote Sensing and GIT), Sören Holm (Forest Inventory), Ola Eriksson (Forest Planning), Dag Fjeld (Forest Technology and Wood Supply) and Dianne Staal Wästerlund (Organization and Leadership).

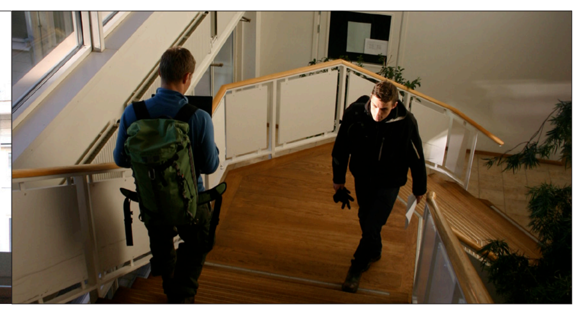
Undergraduate and Master's studies. The individual courses per subject are shown in the table below. Courses at the undergraduate level have 40 to 80 students per course. Courses at the Master's level generally have 5 to 50 students per course.

The development of the thematic courses in industrial Wood Supply has been of particular interest. From an industry-sponsored initiative in 2004 the specialization has grown to attract a stable participation at SLU in Umeå (20-25 students per course). A high degree of sector participation in course concept development and instruction has resulted in good student evaluation. The first year, the Master´s programme Environmental Monitoring and Assessment received students from as far away as Asia and Africa.

During 2010 the total volume of teaching done at the Department was 98 full-time equivalents, corresponding to 96 annual performance equivalents. Approximately 12% of the total volume comes from Master's theses (supervision of 23 theses in 2010).

Strategic goals. The long term goals for educational activities at the Department are to deliver relevant competence to the forest sector through courses of high quality with excellent student evaluations.





Courses Given at the Department in 2010

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

Text: Dag Fjeld
Pictures: Mona Bonta Bergman

Master's Theses Reports

Remote Sensing

Blomberg R. Tillämpning av *k*NN-Sverige i Södra Skogs verksamhet: behovsinventering, databearbetning och förberedelse för praktisk implementering. (Supervisor: Jörgen Wallerman)

Djurberg J. Stamräkning och identifiering av åtgärdsbehov i röjnings- och gallringbestånd med hjälp av låghöjdsbilder. (Supervisor: Mats Nilsson)

Hlaing M. Evaluation of digital surface model data to improve forest biomass estimation from SPOT HRG. (Supervisor: Jörgen Wallerman)

Saitzkoff R. Utvärdering av höjdskattningar av enskilda träd baserat på data från SAAB Bofors Dynamics optiska prototypsystem för 3D-kartering i kombination med en laserskannad markmodell. (Supervisor: Jörgen Wallerman)

Sjödin M. Skattningar i gallringsskog med hjälp av flygburen laserskanning: beräkningar med massa-slutenhet. (Supervisor: Johan Holmgren)

Forest Planning

Eriksson M. Prognostisering av sortimentsutfall från stående skog med hjälp av befintliga data: anpassat till Sveaskog Norrbottens planeringsprocess. (Supervisor: Ola Eriksson)

Karlsson M. Data och metodik för utbytesberäkning: en studie på Medelpads Skogsförvaltning. (Supervisor: Ola Eriksson)

Lindholm R. Implementering av miljöledningssystem i skogsbruket: en fallstudie hos Stora Enso Skog AB. (Supervisor: Dianne Staal Wästerlund)

Malmqvist J. Nästa generations syn på skogsägandet och skogsägarrörelsen: en enkätundersökning bland vuxna barn till dagens medlemmar i Norra Skogs-ägarna. (Supervisor: Dianne Staal Wästerlund)

Sjödin A. Informationsflödets roll i avverknings-kvalitén. (Supervisor: Dianne Staal Wästerlund)

Tellström J. Hur skall skogen skötas?: en analys av skogsfastigheten Fagerdal 2:10 i Jämtland. (Supervisor: Erik Wilhelmsson)

Forest Technology

Andersson E. Bättre åtkomst till avverkningstrakter med anpassat marktryck från avverkningsmaskinerna. (Supervisor: Iwan Wästerlund)

Andersson T. TOMO Hugglink. (Supervisor: Iwan Wästerlund)

Bjarnert J. Reducering av markskador vid GROT-skotning. (Supervisor: Iwan Wästerlund)

Femling J. Uppföljning av planerat skotningsavstånd med hjälp av geografisk informationsteknologi (GIT). (Supervisor: Ola Lindroos)

Forsberg E. Buskröjning längs skogsbilvägar: en produktivitetsstudie av två kättingslagor. (Supervisor: Iwan Wästerlund).

Johansson P. Skogsbränsledrivare i klen förstagallring med contorta. (Supervisor: Dan Bergström)

Karlsson D. Prestation vid sönderdelning av GROT med olika typer av maskiner. (Supervisor: Iwan Wästerlund)

Lindström E. Utveckling av differentierade ersätt-ningar för rundvirkestransporter med lastbil. (Supervisor: Dag Fjeld)

Lindström J. Kartläggning av ruttplaneringsprocesser för rundvirkestransportörer. (Supervisor: Dag Fjeld)

Lindström S. Detektor på skördare för utsortering av träd med metallskrot.(Supervisor: Iwan Wästerlund)

Ohls A. Test av modeller för prioritering av förändringsförslag i Stora Enso Skog AB´s nya produktionsplaneringssystem VSOP. (Supervisor: Dag Fjeld)

Forest in Rural Studies

Roth M. Ledtidens betydelse för privata skogsägares kundnöjdhet i samband med gallring. (Supervisor: Gun Lidestav)

Arvid Lindmans award 2010

Simon Berg was awarded for his Master´s thesis "Skogsentreprenadföretagens lönsamhet" by Arvid Lindmans award 2010. Read his work in full text: http://ex-epsilon.slu.se:8080/archive/00003383/

More information: The Master´s theses 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 doctoral education aims to provide a university education of high quality, where the doctoral students gain both broad knowledge and expert skills in the competence area of their choice. In total 30 students were enrolled. Among these students 17 were men and 13 were women. Three doctoral students concluded their studies, and seven new students were recruited.

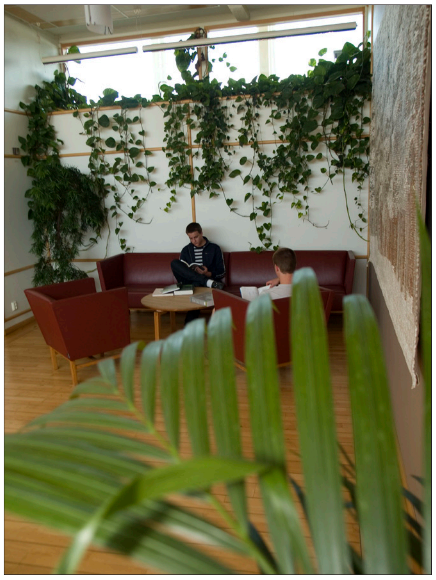
The doctoral students made great progress, and a direct result of this is co-authorship of seven scientific publications. In addition, the doctoral students that finalized their education during the year contributed with co-authorship of five scientific publications. The students have also presented their results at several national and international conferences, meetings and workshops.

The majority of the doctoral students have actively participated in seminars and a doctoral student day organized by the Department. Representatives of the doctoral students have taken part in: the Working Committee of Doctoral Studies (Department level) and the Council of Doctoral Students (organized by doctoral students).

Supervision. Curently 13 different senior researchers act as supervisors and the doctoral students are supported by more than 30 assistant supervisors. The gender balance within the group is uneven with only one female supervisor and four female assistent supervisors.

The role of the Department and Faculty. The Department undertakes an annual review of all doctoral students individual study plans. Then the Director of doctoral studies at the Department reports the outcome of this review to the Faculty. The Director of doctoral studies at the Faculty organizes meetings for the directors at the departments on an annual basis. The aim of the meetings is to inform about new regulations and facilitate harmonization of the doctoral students study.

During 2010, the Department gave the doctoral courses: Laser Remote Sensing of Vegetation, Forestry for Students without a Forest Education, Applied Statistics for Foresters, Strategies for Sustainable Forest Management, Forest Remote Sensing and Statistical Methods for Research with Focus on Application. In total nearly sixty students participated in these courses.



Courses Given at the Department in 2010

Subject	Credits (ECTS)
Laser Remote Sensing of Vegetation	5.0
Forestry for Students without a Forest Education	4.5
Applied Statistics for Foresters	8.0
Strategies for Sustainable Forest Management	7.5
Forest Remote Sensing	7.5
Statistical Methods for Research with Focus on Application	7.5

Text: Hans Petersson
Pictures: Jenny Svennås-Gillner and Viktor Gärdebro

Doctoral Theses

Forest Inventory and Empirical Ecosystem Modeling

Habib Ramezani
Deriving landscape metrics from sample data
November

Supervisor: Professor Göran Ståhl
Assistant supervisors: Associate Professor Sören Holm and Dr Anna Allard

Forest Planning

Eva-Maria Nordström
Integrating multiple criteria decision analysis into participatory forest planning
November

Supervisor: Professor Ola Eriksson
Assistant supervisor: Dr Karin Öhman

International Forestry

Efrem Garedew
Land-use and land-cover dynamics and rural livelihood perspectives, in the semi-arid areas of Central Rift Valley of Ethiopia
January

Supervisors: Associate Professor Ulf Söderberg
Assistant supervisors: Dr Mats Sandewall, Professor Bruce M. Campbell and Dr Habtemariam Kassa

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

Pictures: Patrik Umaerus and Mona Bonta Bergman

Remote Sensing

Combining Terrestrial and Airborne Laser Scanning

Håkan Olsson
Competence Area
Manager

Staff
Peder Axensten
Mikael Egberth
Johan Fransson
Johan Holmgren
Mats Högström
Oskar Jonsson
Mats Nilsson
Karin Nordkvist
Kenneth Olofsson
Anders Pettersson
Emma Sandström
Jörgen Wallerman

Post Doctoral Students
Michael Gilichinsky
Alessandro Montaghi

Doctoral Students
Jonas Bohlin
Ann-Helen Granholm
Eva Lindberg
Mattias Nyström
Andreas Pantze
Heather Reese

Text: Håkan Olsson
Figures: Johan Holmgren and Eva Lindberg

The project "Automatic measurements of tree stems of standing trees" started in 2007 with financing from the research council Formas. The project has during 2009 and 2010 continued as one of the tasks carried out within the Wood Wisdom ERA-Net project IRIS. The aim has been to develop methods for using terrestrial laser scanning of tree stems as training data for airborne laser scanning of forests. The staff involved at SLU has been Eva Lindberg (doctoral student), Johan Holmgren, Kenneth Olofsson and Håkan Olsson.

Measurement of tree stems with Terrestrial Laser Scanning (TLS) provides highly accurate three dimensional data consisting of distance measurements from the scanner to surrounding surfaces. When placed in a forest TLS will provide a three dimensional point cloud of the objects around it (Figure 1). Terrestrial laser scanners are still large and bulky but technical developments are occurring rapidly, and smaller units suited for practical forest inventory are expected to be developed in the future. Traditional field inventories usually focus on measurement of stem diameter at breast height, but TLS has the potential to provide more information about the shape of the tree stem and the branches.

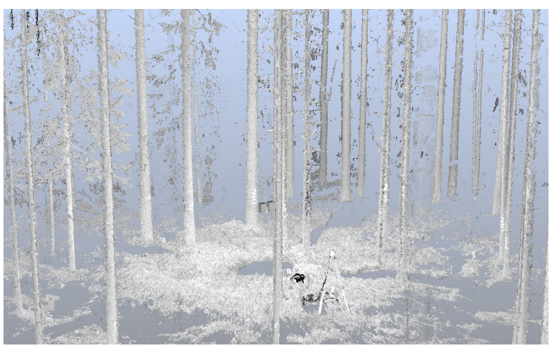


Figure 1. Terrestrial laser scanner data from a field plot with tree stems.

In order to measure tree stems with TLS several processing steps were developed in the project. The ground level was identified by simultaneously searching for the lowest points within grid cells of two different resolutions. Then the position of the tree stems were found by projecting the data to the ground plane and applying an image processing method which highlighted potential stem centers. Finally, the diameter of the tree stems were measured by fitting different sized circles to the point cloud of each stem (Figure 2). An important part of this step was to identify TLS reflections from tree stems only and remove noise due to branches and shrubs. Using the developed techniques, stem diameters at breast height for single trees could be automatically measured with 11% RMSE and less than 0.5% bias.

Data from Airborne Laser Scanning (ALS) are most often analyzed as plot level averages of forest properties like stem volume. High density ALS data also makes it possible to delineate individual tree crowns (Figure 3). Properties of the tree crown segments such as height and width can then be used to predict stem diameter, tree height and stem volume of the corresponding trees. To create models for this prediction, the tree crowns must be co-registered with tree stems measured on the ground. The established prediction models can then be used to estimate tree variables for all trees that are detectable in the ALS data. It should, however, be remembered that only about 70% of the stems, representing about 90% of the stem volume usually are detectable when analyzing airborne laser scanner data on single tree level.

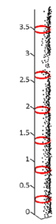


Figure 2. Terrestrial laser scanning reflections from one tree stem and circles fitted along the stem.

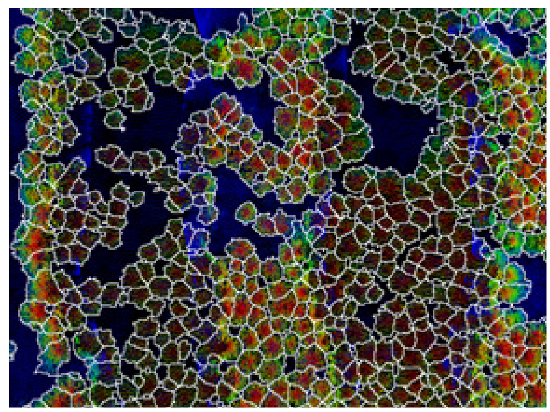


Figure 3. Airborne laser scanner data with segmented tree crowns.

A major advantage of using data from TLS as ground measurements is that the tree positions within the field plot are known. This enables the pattern of tree stems seen from TLS to be matched with the corresponding pattern obtained from ALS. A method to co-register tree stem patterns as seen in TLS with the corresponding tree canopies detected in ALS data was developed in the project. This created the possibility of using TLS data analyzed on single tree level as training data for ALS data.

When building the statistical model for predicting stem diameter as a function of canopy properties measured with ALS, only tree stems which were clearly visible in the TLS data were used for training the model. Validation results show that the estimation accuracy for stem diameter and volume for single trees detected in the ALS data and trained with TLS data were almost as good as when the ALS data models were trained using manual field measurements. Thus, terrestrial laser scanning is likely to be a suitable future technique for training of airborne laser scanning on single tree level.

Forest Inventory and Empirical Ecosystem Modeling

Deriving Landscape Metrics from Sample Data

Landscape level monitoring is gaining increased interest worldwide and programmes such as the National Inventory of Landscapes in Sweden (NILS) have been established in many countries. In addition to provide valuable information about species and habitats, these programmes offer an opportunity to describe landscape state and development at an aggregated level. For this purpose, landscape metrics (indices) are recognized as useful tools that have become increasingly popular in recent years. The metrics are simple measures that summarize and convey complex information about landscape pattern and composition.

The standard approach for calculating landscape metrics is to use wall-to-wall land cover maps from remotely sensed data. However, a recent trend is to use sample data to derive the metrics; the motivations are that the cost may be reduced, the data quality may in some cases be better, and also that this approach offers possibilities for estimating some metrics from already available monitoring data, i.e. from sample based national forest inventories. Figure 1 illustrates the two alternative approaches, e.g. to acquire wall-to-wall polygon data or to take a sample in order to calculate the needed metric.

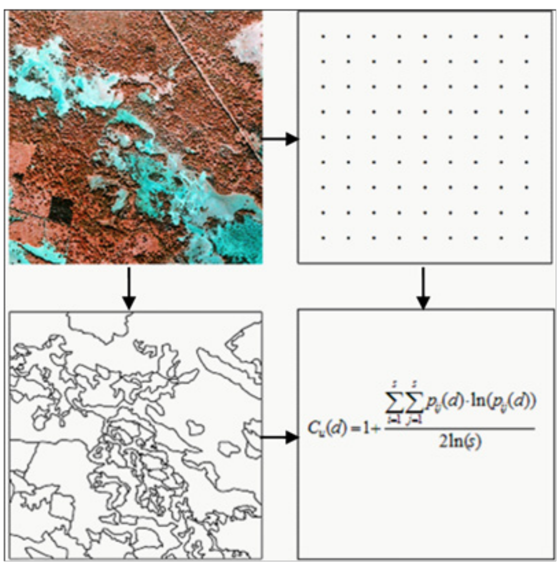


Figure 1. Illustration of how a landscape metric (contagion) can be estimated either based on wall-to-wall data or based on sample data.

To study the efficiency of using sample data to estimate landscape metrics a doctoral project was initiated in November 2004. In this project Professor Göran Ståhl, Associate Professor Sören Holm and Dr Anna Allard supervised the doctoral studies of MSc Habib Ramezani. The project was completed in November 2010 with a successfully defended thesis. In the project it was explored what sampling methods are preferable, in terms of cost and accuracy, to use for the assessment of different landscape metrics. Further, a new vector-based contagion metric was developed and applied in a case study.

It was found that many metrics could be estimated with adequate accuracy at limited cost. In many cases, the estimators were slightly biased, but the bias could be reduced by increasing the sample size. Systematic sampling designs were superior to simple random design (Figure 2); when line intersect sampling was applied longer lines proved to be more cost-efficient than shorter ones.

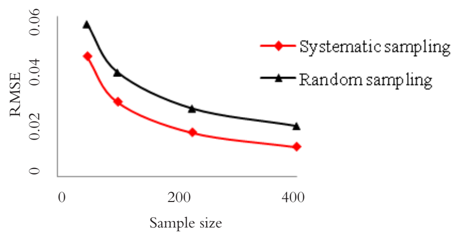


Figure 2. Relationship between sample size and RMSE for the estimator of Shannon's diversity.

For the new distance-dependent vector-based contagion metric it was found that the results could be very well approximated by an exponential function, where the decay (parameter B, in Figure 3) carries information about fragmentation.

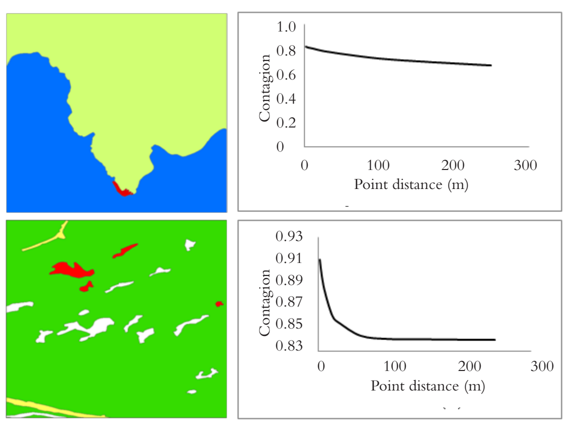


Figure 3. Illustration of two different landscapes and their corresponding contagion function with different B parameters. For the upper landscape the B value is small whereas for the lower it is large.

It was concluded that sample-based estimation of metrics is a promising and cost-efficient alternative to the standard wall-to-wall approach.

Göran Ståhl
Competence Area Manager

Staff
Anna-Lena Axelsson
Henrik Feychting
Anton Grafström
Nanna Hjertkvist
Sören Holm
Torgny Lind
Kenneth Nyström
Hans Petersson
Anna Hedström Ringvall
Stefan Sandström
Martin Vestman

Doctoral Students
Ylva Melin
Habib Ramezani
Cornelia Roberge
Sebastian Schnell
Nicole Suty
Sören Wulff

Guest Researcher
Bronson Bullock

Text and figures:
Habib Ramezani

Ola Eriksson
Competence Area
Manager

Staff
Hampus Holmström
Tomas Lämås
Dianne Staal Wästerlund
Peder Wikström
Erik Wilhelmsson
Karin Öhman

Post Doctoral Student
Sofia Backéus

Doctoral Students
Anu Korosuo
Malin Nilsson
Eva-Maria Nordström
Lars Sängstuvall

Text and figure:
Ola Eriksson and
Karin Öhman

Forest Planning

Forest Planning with Consideration to Water Quality

A large proportion of the lakes and streams in Sweden are located on forest land. As a result, the way the forest is managed influences the water quality. Hydrological issues and biological and chemical processes in the water are influenced by activities such as harvesting and fertilization. These ordinary forest operations tend to affect the water quality negatively compared with the status of non-managed forests. One reason for the increased interest in water quality during the last decade is the EU Water Framework Directive (WFD), which purpose is to prevent further deterioration and to improve the status of aquatic ecosystems. The EU WFD should be used for regulating emissions from point sources like sewage treatment works, but also from diffuse sources such as forestry. According to the EU WFD, the water quality in pristine areas, unaffected by human activities, should act as reference areas for determining the surface water status.

The vision is to achieve good ecological and chemical status of lakes and streams in Europe by 2015. Therefore, it is likely that the EU WFD will have consequences for how forestry can and should be conducted on the stand level as well as on the catchment level. In addition, water quality aspects are included in at least eight of the national environmental goals for Sweden, e.g. Flourishing Lakes and Streams and Natural Acidification. It is therefore essential that the impact on water quality from various roles, such as forestry, is evaluated.

Guidelines for mitigating the negative effects of forest operations on water quality have been issued. However, how severe the limitations on forestry will need to be to maintain or achieve a certain water quality over time is an area with limited research both at a national and international level. Neither has the question of how forestry could adapt to water quality requirements been investigated. In general, there are two ways of including water quality aspects in the optimization of forest planning aiming at determining how to best achieve economic goals while reaching water quality targets. The first is to use constraints that restrict the management in some way by rules of thumb, for example, not more than 30% of the area of a watershed should be harvested. However, it is not obvious that rules like these are either optimal or sufficient. The other way is to use water quality models that try to mimic the actual effects as a function of selected management, even if this could result in very complex forest planning problems. One explanation for the complexity lies in the quantifying of the cumulative effects on water quality from multiple harvesting activities over space and time within a watershed. Planning for timber production can often be done without representing spatial relationships between stands this is not the case for water quality. However, planning problems that include spatial relationships tend to be difficult to solve. As a result, including water quality models into the planning process makes the optimization process more complicated and other optimization approaches than the traditional ones have to be used.

The aim of the projects at the Department regarding water quality is to show how water quality aspects can be integrated into the forest planning process of forest companies, private landowners or municipalities. The projects are focused on creating the tools needed for planning for both timber production and water quality, and to test these tools in practical case studies in collaboration with representatives of forestry and water issues.

Results from ongoing studies show that forest management planning in watersheds needs models of water quality to balance the export of harmful substances against the economic loss. In one study of a watershed of 6000 ha the amount of Dissolved Organic Carbon (DOC) could be limited to a maximum of 10% above the reference level over a 100-year period, however at the expense of the economic yield in terms of Net Present Value (NPV) in the range of 5-30% depending on the assumptions of parameters values in the model. In another study, DOC as well as phosphorus, nitrogen and methyl mercury were analyzed (Figure 1). This study concerned a small watershed of 238 ha. The results indicate that if exports are limited to a maximum of 10% increase from the reference level over a period of 100 years the economic loss could be in the range of 20-35% depending on whether the limitation is set for the total watershed (One unit) or for each sub-watershed (Three units).

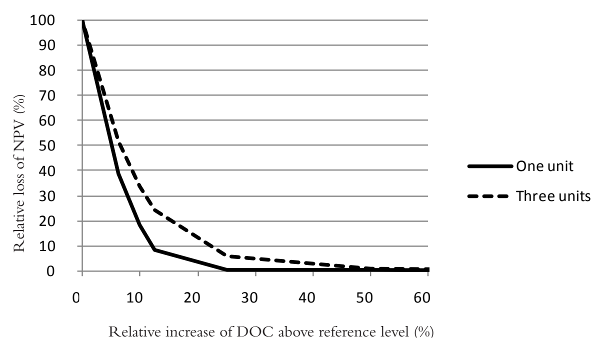


Figure 1. The relative loss of Net Present Value (NPV) as a function of the relative increase of Dissolved Organic Carbon (DOC) above the reference or undisturbed level. One unit refers to when the requirement is applied to the entire watershed as one unit and Three units when the requirement is applied to each of three sub-watersheds.

Even if there are uncertainties in the water quality models used in the studies, results show that it is possible to include water quality aspects in forest analysis and the planning process. The results further indicate that the requirements to enhance water quality stipulated by the EU WFD may influence forest management, both concerning how the forest is managed and the economic yield.

Forest Technology

Soil and Vehicle Interactions

The research conducted within the competence area of Forest Technology aims at developing environmentally friendly methods and techniques for timber and forest fuel procurement in an efficient way. Below are two examples of soil damage studies that were conducted in 2010.

1. Increased forwarding with suitable ground pressure from the machines. The global climate change means increasing mean temperature and higher precipitation in Sweden, which leads to shorter periods of frozen ground in the forest. At the same time the harvesting machines are getting bigger and more powerful. The forest industry demand an even flow of timber, and at the same time a limitation of the ground damage made by the machines. The main cause for ground damage is that the bearing capacity of the forest ground is too low in comparison to the ground pressure of the harvesting machines. The aim of this study was to find guidelines for the machine choice when harvesting on ground with low bearing capacity. A field study, using a Valmet 890.3 forwarder, was carried out where different ground pressures and their effect on the ground were tested on two different types of ground. Additionally, an inventory of damaged harvesting grounds was made. The rut depth and soil strength was measured and the ground pressure of the harvesting machines was calculated.

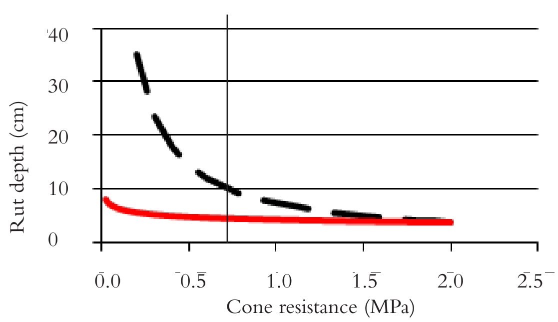


Figure 1. Model for rut formation after harvesting work depending on soil strength and cone resistance in the upper 20 cm soil depth. The red line represents machines having less than 75 kPa estimated ground pressure and black dotted line those above 80 kPa ground pressure.

The result shows that rut depth as well as soil compaction is less if the ground pressure from the forwarder is reduced by using tracks. For forwarders with high ground pressure (> 80 kPa), the rut depth increased significantly when operating on ground with cone resistance < 0.70 MPa (Figure 1). However, it is important to point out that the forest ground is very complex in its composition, and that it is difficult to predict damage to it (e.g. rut depth). Heavy rain could lower the bearing capacity considerably.

2. The fuel consumption of a forwarder driving on soft ground with bogie tracks. Swedish forestry has as one of major focuses to decrease the fuel consumption at forestry work. For the moment it is estimated that the average fuel consumption is 1.7 l/m^3 harvested wood from stump to landing and half of it emanate from the off-road transport of timber. The forwarder, the machine that carries the timber from the stand to the landing, is the machine that makes most damage to the ground. Rut formation after machine and fuel consumption with different types of bogie tracks was measured with an eight wheeled loaded forwarder (Valmet 860.3). On soft ground the good types of bogie tracks reduced fuel consumption considerably due to better floatation on the ground and thus making less ruts.

The bogie tracks add some mass to the machine. The extra mass on the wheels gives the advantage of lowering the centre of gravity point, increasing the contact area to the ground and increasing the stability of the machine when driving in uneven terrain. On the other hand it increases the mass the machine has to transport both the extra mass and presumed increased rolling resistance on hard ground will cause extra fuel consumption. On normal soft ground it will be an advantage to have good types of bogie tracks (same rolling radius as the tyre) to reduce the rutting of soil. Calculated as fuel consumption per transported mass, it was surprisingly small difference in fuel consumption per ton between driving on hard ground with rubber wheels and good tracks on normal half soft forest ground (Table 1). On the wet soft soil (cone resistance of 0.45 MPa) fuel consumption increased of course, but here the ruts were also between 10 and 25 cm indicating heavy rolling resistance.

Contact device	Ground	Tracks no	l/h	Mass, ton	l/h per ton
ECO-Baltic	Forest wet	4	20.4	32.3	0.64
ECO-Baltic	Forest norm	4	16.6	32.3	0.51
ECO-TRACK	Forest wet	4	20.3	32.6	0.62
ECO-Baltic	Road	4	9.6	19.1	0.50
ECO-TRACK	Road	2	8.8	17.7	0.48
Wheels	Road	0	7.5	15.8	0.48

Table 1. Summary of the test series with calculated fuel consumption per transported mass in ton.

National Soil-Vehicle working group. Within the Technical co-operation group (TSG) at Skogforsk a Soil-Vehicle working group has been formed this year. Chairman is Göran Andersson, Korsnäs, secretary is Iwan Wästerlund, SLU and the two other members are Björn Löfgren, Skogforsk and Lars-Göran Göransson SMF. The aim is to reduce the rutting to half by year 2014.

Iwan Wästerlund
Competence Area Manager

Staff
Dimitris Athanassiadis
Dag Fjeld
Kalvis Kons
Ola Lindroos
Magnus Matisons
Tomas Nordfjell

Post Doctoral Students
Dan Bergström
Fulvio di Fulvio

Doctoral Students
Simon Berg
Jeanette Edlund
Mattias Eriksson
Emanuel Erlandsson
Back Tomas Ersson
Carola Häggström
Jussi Manner
Maria Nordberg
Daniel Persson
Mindaugas Puodziunas
Gunnar Svenson

Text: Iwan Wästerlund
Figure: Erik Andersson
Table: Iwan Wästerlund
and Erik Andersson

Forest in Rural Studies

Local Development Perspectives on Business Practices Based on Family Forest Farms – Constraints and Potentials for Future development

Gun Lidestav
Competence Area
Manager

Staff
Solveig Berg Lejon
Johanna Liljenfelt
Maria Högvall Nordin
Per Sandström

Doctoral Students
Elias Andersson
Mersha Gebrehiwot
Patrik Umaerus

Guest Researchers
Carina Keskitalo
Nicole Klenk

In this multidisciplinary project biological and institutional potentials and constraints, in different types of business activities based on a forest property, are examined and put in a local development context. Local development is here defined as the ability to create and maintain good living conditions based on the sustainable use of the local resources. As the business activities can be regarded as social practices, structured and constructed by the formal and informal institutions, this interaction is of vital interest.

Based on the assumption that the potentials and constraints acts differently on the different activities, a variety of interactions are expected. Yet, there is likely to be some common features between those with similar business activity. Traditional timber production will be contrasted and compared with the production of "new" products and services. The studied business activities will in a sense describe a gradient from traditional timber production to a production of services demanded by a (post) modern society. Biological potentials to produce timber, wildlife and fish for consumptive use as well as non-consumptive use such as rehabilitation by so called green care, will be assessed as well as economical potentials for the individual business activity. Further, the project will look into the interaction between the business practice and the gender system.

So far the impact of gender on traditional and new businesses based on family forestry farming has been assessed by analysing the Federation of Swedish Farmers member database from 2009. The results reflect traditional gender power relations at family forest farms. The business activities where the proportion of female operational managers is lowest, are those where the traditional gender power relations are still prevailing. These activities are to a higher extent commodity oriented and connected to traditional forest activities, such as forestry contracting or wood processing. Correspondingly, higher shares of female operational managers are found in business activities where the traditional gender power relations have been loosened up. This is especially evident in the business activities green care and tourism, typically service oriented businesses (Figure 1).

These activities and green care in particular also seem to make way for joint venture between men and women, although green care is still practiced only to a limited extent. On the arena that the family forest farm constitutes, men and women have dissimilar possibilities to develop business activities. Men are in general in possession of considerably more land than women (Figure 2) and have a dominant position within traditional business activities linked to forestry and production of commodities. The conclusion is that women's possibilities to develop business activities at family forest farms are limited by the gender order.

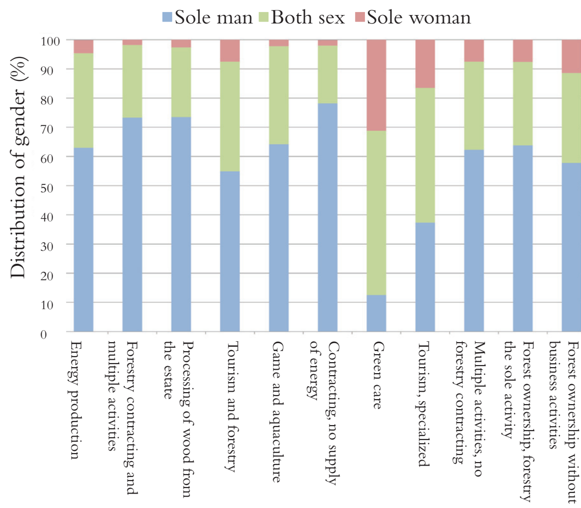


Figure 1. The distribution of gender in the operational managements within each cluster.

Figure 2. Mean area of forest and arable land within each cluster.

Henceforth, a number of case studies will be performed examining the current and future ecological capacity for timber, wildlife, fish and nature conservation given a certain business activity such as hunting tourism or green care. Also, what interest is there in developing such business activities? Who are successful and what makes their businesses successful? Another issue to be examined concerns what part the owner's identity and sense of place play when choosing the type of production or business activity.

This Formas financed project, running from 2008 to 2012, is a coherent forest theme within the Graduate School in Rural Development at SLU. The project team involves two doctoral students: Patrik Umaerus at the Department and Anders Kagervall at the Department of Wildlife, Fish and Environmental Studies, and five senior researchers: Gun Lidestav, Carina Keskitalo and Ola Eriksson at the Department, Ann Dolling and Ylva Lundell at the Department of Forest Ecology and Management, and Göran Eriksson at the Department of Wildlife, Fish and Environmental Studies.

Text: Patrik Umaerus
and Gun Lidestav
Figures: Patrik Umaerus

International Forestry

Linking Forest Policy Development and Information Collection in Nicaragua

This project is derived from the experience that the forest sector can contribute to poverty reduction and a sustainable economic development. One important pre-requisite for sustainability is a sound and supportive forest policy based on accurate information about the current situation and trends. Our Swedish experience is one successful example, but in many countries the potential of the forestry sector in social and economic development is not well utilized and there is weak connection between forest policy and efficient use of data and information.

The project is named "Strengthening institutional capacity in the forest sector of Nicaragua promoting the collection of information and the National Forest Programmes process". It is part of the Forest Initiative Programme (a strategic partnership between Sida, the Swedish Forest Agency and the Swedish Forestry Association). The project which started in April 2010 is implemented by the Department (through Mats Sandewall, Ulf Söderberg and Gun Lidestav) in close collaboration with the Swedish Forest Agency (Erik Sollander and Karl Duvemo), the National Forest Programme Facility of FAO and the local partner, the Nicaraguan Forestry Department INAFOR. A Swedish forestry student Annie Sandgren is involved to do a field study within the project.

The ambition in this project, in general terms, is to strengthen forest policy development through exchange of timely and useful information from and among all relevant stakeholders about the forest sector. The specific project objectives are 1) to improve experience of developing effective knowledge-based forest-sector policies on country level and globally, which address poverty reduction and a sustainable development and, 2) to identify the information demanded by the policy process, link it to the data available and data collected within the National Forest Assessment and suggest how the information should be presented and made accessible to the policy process. The project country (Nicaragua) was proposed by FAO based on the presence of a National Forest Programmes process, a recently completed National Forest Monitoring and Assessment and a strong local interest in the project objectives.

The expected project outcome is a broad understanding within the forestry sector of "how to go about" the task of developing knowledge-based forest policies acceptable to society. The approach of the project is therefore process oriented. At the initial stage "deforestation" was proposed by the local partner as a working case. The project activities are centered on a number of workshops and training courses with intermediate periods of (i) gathering of existing data, (ii) analysis of those data in relation to a prioritized policy issue, and (iii) strategic pilot studies aimed to cover major knowledge gaps. Those studies are proposed by a policy/data analysis group and carried out by Nicaraguan and Swedish university students.

This ongoing project will be completed and its outcome evaluated in 2011. If positive, it would be used as a model case for addressing similar difficulties faced by a number of other countries developing national forestry programmes.

Pictures: Rapid conversion of forests into land for livestock production is a major policy issue analyzed in the project. The development contradicts with existing forest legislation, but is promoted by demands from the agriculture sector. University students from Sweden and Nicaragua carry out field based pilot studies in cooperation with the project.

Mats Sandewall
Competence Area Manager

Staff
Ulf Söderberg

Doctoral Student
Efrem Garedew

Text and pictures:
Mats Sandewall

Environmental Monitoring and Assessment

Mats Nilsson
Vice Head
Environmental Monitoring and Assessment

Acting Vice Head
Hans Gardfjell

Staff
Svante Lindroth

Halting the loss of biodiversity and stopping the climate change are global issues that have given rise to several international conventions, directives and treaties. Examples are the Convention of Biodiversity, focusing on halting the loss of biodiversity, the European Habitats Directive which tries to limit the loss of species and habitats with high conservation value, and the Kyoto Protocol that intend to limit the emissions of greenhouse gases. The implementation of these agreements has increased the demand for accurate environmental monitoring data.

The Swedish government has charged SLU with the task of conducting and developing environmental monitoring and assessment. This gives SLU a unique position among Swedish universities and SLU is collaborating closely with several public authorities to fulfill the monitoring and reporting demands that come from international legislation and treaties. SLU monitors land use, land cover, forest biomass, vegetation, greenhouse gases, nutrient flow, biodiversity and wildlife in all kinds of ecosystems and habitats in order to analyze and report on the status and trends in our environment.

The Department has a long tradition of working with environmental analysis. The Swedish National Forest Inventory (NFI) started already in 1923 and over time the programme has achieved advanced skills in sampling theory, data management and field work 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 in this annual report. Currently the environmental monitoring programmes accounts for two-thirds of the total budget of the Department.

The collected information are available to different stake-holders, e.g. the Swedish government, national and regional public authorities, research projects, as well as private companies and NGO's.

The combination of research and environmental monitoring activities is one of the strengths at 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 different research projects. The connection between environmental monitoring and assessment and undergraduate and Master's studies is also important. It improves the dissemination about environmental monitoring activities, knowledge needed for effective decision making and sustainable use of our natural resources.

Text: Hans Gardfjell
Picture: Helena Forsman

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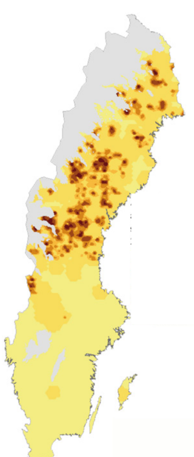
National Forest Inventory

Lodgepole Pine in Sweden

Data from the Swedish National Forest Inventory (NFI) is part of Sweden's official statistics. Annually the NFI publishes official statistics for Sweden on the web (http://www.slu.se/en/webbtjanster-miljoanalys/forest-statistics/) and in the printed publication Skogsdata, that also includes a themed chapter. For the 2010 publication the theme, written by Neil Cory, was Lodgepole pine (Pinus contorta var. latifolia) in Sweden. Data from both sample plots and sample trees within the NFI have been used to describe the status of Lodgepole pine in Sweden and to compare it with the indiginous Scots pine (Pinus sylvestris). This data enables us to undertake an assessment of the de facto status of Lodgepole pine in Sweden.

Lodgepole pine is a hardy coniferous tree originally from the western regions of North America. Lodgepole pine has a higher production rate than our indiginous Scots pine. The large scale introduction of Lodgepole pine to Sweden started in the 1970's to help avoid a predicted future shortage of timber. The first of these stands are now up in commercial thinning age.

Lodgepole pine forests, defined as having at least 65% Lodgepole pine, cover an area of about 475 000 ha, principally in the north of Sweden. Lodgepole pine forests are primarily owned by the large scale forestry sector. Establishment of Lodgepole pine stands was at a peak in the middle of the 1980's and has subsequently declined.



Proportion of lodgepole pine forests of the productive forest land 2005-2009

- 0
- 0.1-2.5
- 2.5-5
- 5-10
- 10-20
- 20-100

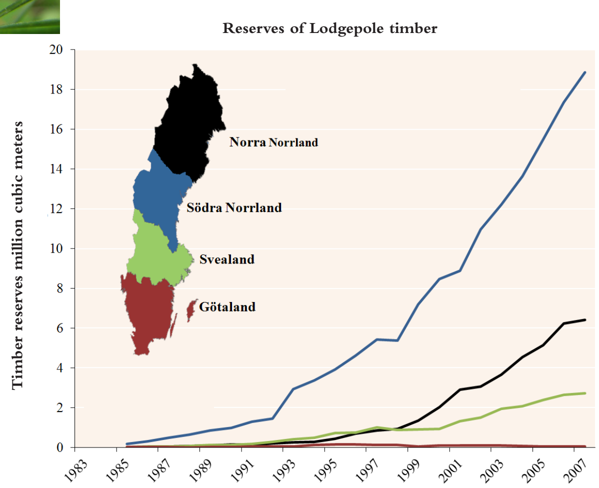
However, the established stands have developed and the standing volume of Lodgepole pine has increased dramatically to about 28 million cubic meters, which represents 1% of Sweden's total standing volume. In the southern county of Norrland the proportion of Lodgepole pine is 2.6% of the total standing volume. Lodgepole pine is now Sweden's seventh most common tree species.

Forty years have passed since the large scale introduction of Lodgepole pine commenced and today about 50% of the Lodgepole pine forests are of commercial thinning age.

One of the primary reasons for the introduction of Lodgepole pine into Sweden was its high production rate. A comparison between Scots pine and Lodgepole pine of similar age and on ground of similar site class showed that Lodgepole pine has 39% higher volume per hectare than Scots pine.

Lodgepole pine is affected to a greater degree than Scots pine by different types of stem damage. Twenty-eight percent of Lodgepole pine trees showed at least one form of stem damage compared to 21% of Scots pine stems. This damage is dominated by stem failure caused by climate related factors such as snow and wind. Lodgepole pine is affected to a lesser degree than Scots pine by fungus and damage from vertebrate animals.

Lodgepole pine showed a higher degree of stem damage which resulted in a negative effect on timber quality than Scots pine. For example, bowed stems and thick branches.



A digital copy of Skogsdata including the fulltext version of this chapter about Lodgepole pine, in Swedish, is available from the Swedish NFI's home page: www.slu.se/nfi

Jonas Fridman
Program Manager

Staff

David Alger
Mikaela Asplund
Härje Bååth
Neil Cory
Jonas Dahlgren
Bo Eriksson
Joakim Eriksson
Karl-Erik Grundberg
Mikael Holmlund
Göran Kempe
Anders Lundström
Per Nilsson
Patrik Norman
Gunnar Odell
Bo-Gunnar Olsson
Anders Pålsson
Anders Sjöström
Mats Walheim
Bertil Westerlund
Hans Åkesson

Text: Neil Cory
Pictures: Mikael Egberth (Stand) and Ola Borin (Close-up)
Figures: Neil Cory

Johan Svensson
Program Manager

Staff
Anna Allard
Per Andersson
Sofia Andreassen
Pernilla Christensen
Erik Cronvall
Åsa Eriksson
Åsa Gallegos Torell
Merit Kindström
Anders Lindblad
Björn Nilsson
Liselott Nilsson
Lina Rasmusson
Saskia Sandring
Camilla Stenlund
Marcus Strandberg
Karin Terä
Maud Tyboni
Karin Wikström
Marianne Åkerholm
Joakim Åström

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

National Inventory of Landscapes in Sweden

NILS Approaches the Landscape Scale

The NILS programme, in operation since 2003, is developed to monitor and analyze conditions and changes in landscape biodiversity and land use, as basic input to national and international environmental frameworks and reporting schemes as well as to applied research. A central component is to have a landscape scale approach in data and analyses. Therefore, the monitoring design includes geographically large sample plots and an inventory method that is feasible on larger geographical scales. The set up consists of in total 631 plots covering all terrestrial habitats in Sweden, where each plot is a 25 km^2 square. Two parallel and integrated inventories are conducted; field inventory and interpretation of digital infrared aerial images. This allows combination of different types of data to specifically address current problems and challenges in a landscape context.

So far there has been a focus on a central of 1×1 km^2, within the 25 km^2 sample plot, where, a field inventory is conducted on a set of 12 inventory plots and 12 inventory lines to capture both areal features (e.g. cover of trees or bottom layer mosses) and linear features (e.g. forest edges, streams). The inventory plots are composed of a sequence of circular plots with different radii; 20 m, 10 m, 3.5 m and 0.28 m, where different types and sets of variables are documented. The aerial photo-interpretation generates polygon, linear and point information in a 1.1×1.1 km^2 layout.

A combined field inventory and aerial photo-interpretation allow for analyses on various geographic scales, from specific features such as occurrence of certain species on point scale (0.25 m^2) to large-scale analyses (25 km^2) on the spatial composition of habitats, land use and other important landscape information. With developed and developing methods for the 1×1 km^2 inventory, the NILS programme currently advances methodological approaches to complete the 25 km^2 sample unit, including both field inventory and remote sensing, under an intensive dialogue and operational co-operation with various stakeholders. Monitoring on such broad geographical scales needs careful consideration concerning cost effectiveness relative to what is practically possible and scientifically sound.

Ongoing landscape scale approaches are illustrated in Figure 1, which exemplifies a NILS 25 km^2 sample plot. The (1) NILS monitoring infrastructure has proven to be robust to additional and supplementary inventories. The 12 inventory plots and lines are indicated and also the area with complete aerial photo-interpretation. In 2006 a national inventory was added on (2) Pastures and Semi Natural Grasslands and on Patch Habitats in Arable Land (polygon, line and point features), with the objective to extract data and analyze changes and trends in such habitats to respond to the Environmental Quality Objectives. Much of the environmental reporting is done on the county level, however, there is also a need to develop regional approaches as a complement to the national level monitoring. Since 2009 Regional Environmental Monitoring is conducted, for (3) a sample of Wetlands and Meadows in the 25 km^2 plot, and for (4) Patch Habitats in Arable Land systematically within a 3×3 km^2 subplot. In 2009 NILS also initiated a project on (5) combining the NILS biophysical landscape data with the data collected in the Swedish Bird Survey, for co-analyses of cause and effect on bird population behavior. Here the same 3×3 km^2 subplot is used. In 2009 also the (6) Monitoring Of Terrestrial Habitats (MOTH) inventory was included in the NILS 25 km^2 plot. This inventory is focused on developing methods for and collecting data on terrestrial Nature 2000 habitats as input to the EU Habitats Directive.

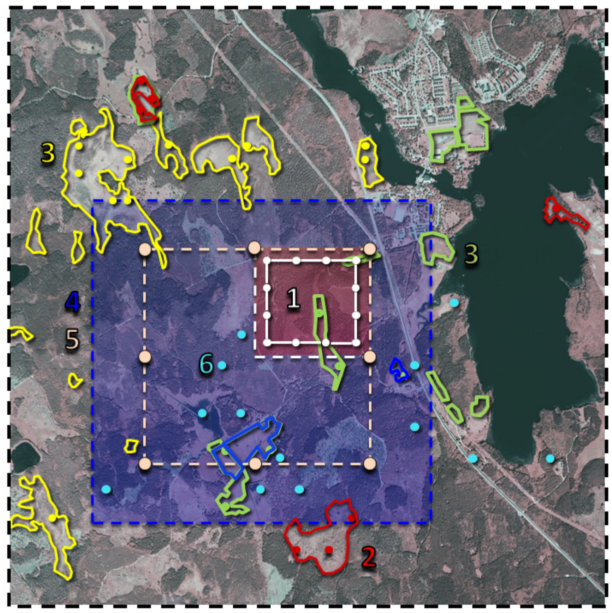


Figure 1. A NILS 25 km^2 sample plot with currently ongoing monitoring and analyses.
(1) NILS – Swedish Environmental Protection Agency (EPA)
(2) Pastures and Semi Natural Grasslands – Swedish Board of Agriculture. The aerial photo inventory on Patch Habitats in Arable Land is done with aerial photo-interpretation within the NILS 1.1×1.1 km^2 plot.
(3) Regional Environmental Monitoring of Wetlands and Meadows – County Administrative Boards
(4) Regional Environmental Monitoring of Patch Habitats in Arable Land – County Administrative Boards
(5) NILS – Swedish Bird Survey project, with the eight bird survey points and transects included – Swedish EPA
(6) MOTH habitats – Swedish EPA and EU Life+habitats, as for Swedish broadleaved forests.

Taken together the NILS programme approaches the landscape scale in monitoring and analyses, by combining various monitoring incentives, techniques and methods, in close co-operation with other landscape actors and stakeholders.
More information is available at the project homepage http://www.slu.se/nils

Text: Johan Svensson
Figure: Åsa Gallegos Torell

Terrestrial Habitat Monitoring

Monitoring Of Terrestrial Habitats (MOTH) is a collaboration project between SLU and the Swedish Environmental Protection Agency (EPA). 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 main 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. Further, we will show how the habitat monitoring system can be integrated in the framework of existing landscape level monitoring programmes that exist today in many European countries. Methodologically, we have developed a two-phase design for habitat assessment that combines interpretation of aerial photos with assessments in the field. The project will implement all steps necessary to present a fully functional monitoring programme.

The Swedish National Forest Inventory (NFI) and National Inventory of Landscapes in Sweden (NILS) are two ongoing programmes at the Department that collect data on coverage and status of terrestrial habitats. MOTH will compile and validate this information. Preliminary studies have shown that general monitoring programmes are able to deliver accurate data from common habitats. However, from less abundant habitat types the precision may become too low to fulfill the requirements needed in the reporting. We have therefore developed a different sampling protocol that specifically targets sparse terrestrial habitats with high conservation values.

The two-phase sampling is made in all regions in Sweden. The sampling unit is a landscape plot with a size of 5.0×2.2 km^2. 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.

During 2010 we surveyed 63 landscape plots with a total of 12 446 grid-points. Of these grid-points, 880 were visited in the field. Results from the first field season were presented at the MOTH Workshop, 2nd December in Uppsala. The project was also presented at the Life+ Platform meeting in Fyn, 20-21th September, at the EBONE general assembly meeting in Västerås, 30th September, and at the Habistat Workshop in Brussels, 13th October. An international reference group was assembled and their first meeting was held in Uppsala, 3rd December. The group consists of ten members from seven countries. Collaboration has also been initiated with Lantmäteriet in Luleå. During the autumn we have together improved the photogrammetric protocol and Lantmäteriet will continue to participate in the interpretation of aerial images during the 2011 inventory season.

MOTH is a Life+ project financed by the European Commission, EPA 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/264. 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.

Office staff: Åsa Hagner, Helena Forsman, Linda Ågren, Sören Holm, Åsa Gallegos Torell, Åsa Eriksson, Anders Lindblad, Liselott Nilsson, Anders Pettersson, Joakim Åström, Marcus Strandberg, Maud Tyboni, Karin Wikström

External collaborators: Gudrun Norstedt, Henrik Weibull, Anna Andersson, Åsa Hedlund Kristofersson, Helle Skånes, Wenche Eide, Hans Kallur, Kjell Lagerqvist, Conny Jacobson and Mark Marissink.

Hans Gardfjell
Project Leader

Staff
Helena Forsman
Åsa Hagner

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

Text: Hans Gardfjell
Pitures: Wenche Eide and Helena Forsman

Environmental Management System

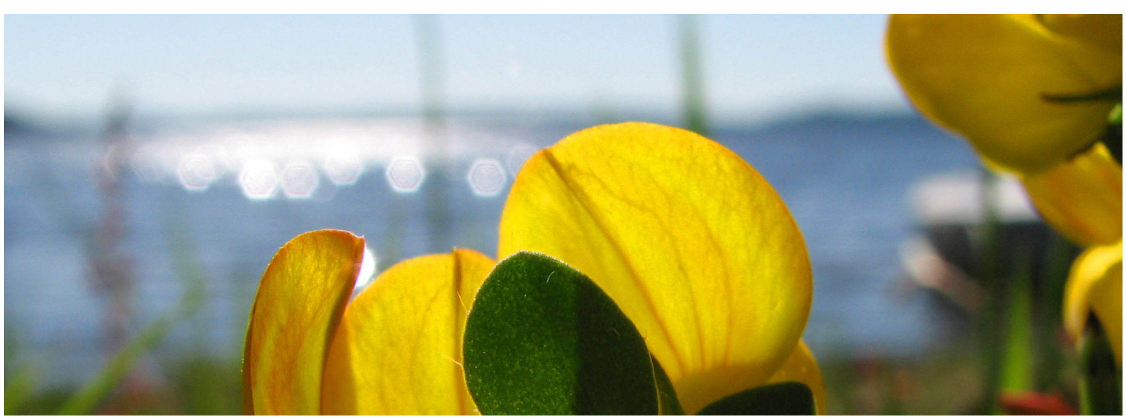
ISO14001: Certificate renewed

After external revision in September, the Department was awarded renewal of its ISO 14001 certificate. The Department has been certified according to the ISO 14001 standard for environmental management systems since 2004. As the Department is heavily engaged in environmental monitoring and environmental activities, it is the Department´s goal to optimize its own positive impact on the environment and look for improvements in its own actions. The ISO 14001 certificate shows that this is carried out in a systematic way. The certificate is awarded after external revision of an impartial certification organization. At present, the Department is the only one at SLU that has a certified environmental management system. As its overall environmental policy, the Department has adopted the SLU policy. Furthermore, the Department has developed a management system and a environmental manual, which all employees have access to. All employees are familiarized with its content during a ½ day course. The Department organized such a course in May 2010 for new employees. Connected to the handbook is an electronic workplace for reporting problems or good ideas to improve the system.

During 2010, the Department had three environmental objectives:

1. Strengthen the environmental content of the undergraduate education at the Department
2. Strengthen the environmental content of the doctoral studies at the Department
3. Redistribute traveling to more environmentally friendly alternatives

For each objective environmental targets were formulated and monitored. Objective 1 is monitored by the subject co-ordinators for our undergraduate and Master´s studies: Jonas Bohlin, Sören Holm, Ola Eriksson, Dag Fjeld and Dianne Staal Wästerlund. Objective 2 is monitored by the Vice Head and Director of Doctoral Studies Hans Petersson and Eva-Maria Nordström, and objective 3 is monitored by Pernilla Christensen, Härje Bååth, Ulf Söderberg and Anders Sjöström. The Deputy Head of the Department, Karin Öhman, is responsible for the environmental management at the Department. She is assisted by Dianne Staal Wästerlund and Per Nilsson who were environmental co-ordinators at the Department during 2010.



Text: Dianne Staal Wästerlund
Pictures: Ola Borin

Publications

The publication list below includes work that was published during 2010. 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.

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- Pantze A., Fransson J.E.S. and Santoro M. 2010. Forest change detection from L-band satellite SAR images using iterative histogram matching and thresholding together with data fusion. In Proc. IGARSS 2010 Symposium, Remote Sensing: Global Vision for Local Action, 30th Anniversary, Honolulu, Hawaii, USA, 25-30 July, 2010, pp. 1226-1229.
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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

Leif Andersson
Lars Bengtsson
Johan Bergstedt
Tommy Bohman
Ola Borin
Åke Bruhn
Stefan Callmer
Bert Carlström
Janne Dahlén
Hans Davidsson
Lars Davidsson
Bo Hansson
Robert Holmgren
Lennart Ivarsson
Karin Jansson
Klara Joelsson Hedemyr
Daniel Johansson
Fredrik Johansson
Mats Jonasson
Karolina Karlsson
Michael Krook
Håkan Larsson
Elin Lindström Jönsson
Magnus Lindström
Ylva Linnman Vänglund
Juha Loenberg
Peter Lundin
Urban Lundin
Jonas Muntlin
Kalle Nordin
Lennart Norlén
Ingemar Olandersson
Stig-Arne Olofsson
Mikael Olsson
Lotta Risberg
Henrik Salo
Liisa Sars
Leif Silversund
Lena Silversund
Björn Sjöberg
Linda Svedberg
Bernt Svensson
Natalia Svensson
Petra Svensson
Jonas Tellström
Ola Tjernberg
Karl Walheim
Elin Wallquist
Jonas Westerlund
Sofia Vestin
Staffan Williamsson
Hailu Zelleke

National Inventory of Landscapes in Sweden

Lina Ahnby
Sven Bengtsson
Nina Dahlerup
Markus Engvall
Fredrik Enoksson
Magnus Granbom
Linnea Helmersson
Erik Holm
Emma Hultén
Ruaridh Hägglund
Eva Hörnström
Bo Karlsson
Mattias Lif
Erland Lindblad
Karin Lundberg
Emma Lundh
Assar Lundin
Ralf Lundmark
Anders Malmsten
Peter Nielsen
Frida Nilsson
Jenny Olsson
Eva-Lotta Nordkvist
Karolin Ring
Niina Sallmén
Maria Sjödin
Albert Tunér
Ulrika Westling
Karin Wikström

Specific Adapted Monitoring of Forest Damage

Magnus Bernhardsson
Staffan Edström
Malin Rantanen
Olle Sundlöf

Department of Forest Resource Management
Swedish University of Agricultural Sciences
SE-901 83 Umeå, Sweden
Telephone: +46 (0)90-786 81 00
Internet: www.slu.se/srh