Department of
Forest Resource Management

Annual Report 2022

Dear Reader,

Contents

Cover photo:
Björnlandet National Park, Ola Borin, SLU.
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Hans Petersson, SLU.
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Emma Sandström, SLU.

The Department of Forest Resource Management leads Swedish terrestrial environmental and resource monitoring through its environmental monitoring and assessment (EMA) activities, research and teaching. We provide different stakeholders with objective decision support for society's needs. For the sake of future generations, and ours, the decision support must be sufficiently comprehensive and of high quality.

Our EMA flagships are the Swedish National Forest Inventory and the National Inventory of Landscapes in Sweden, which monitor historical trends as well as the current situation, while the Heureka simulation system provides an insight into the future. Our research focuses on improving and streamlining monitoring (Forest Remote Sensing, Forest Inventory and Sampling, Mathematical Statistics Applied to Forest Sciences) and providing information on managed and efficient use of natural resources in a broad sense (Forest Planning and Landscape Studies). We are proactive and strive to have a vision of which issues will be the most important ones in the future. In addition, our teaching aims to spread knowledge and secure the skills supply within and outside SLU. For this to succeed, our aim is to have an efficient organisation where the support functions play an important part. The organisation is based on cooperating towards a common goal.

The Annual report 2023 is a summary of a selection of the activities conducted during 2022 and cannot account for everything. Many grant applications were made on both the research side and the EMA-side. For example, the FORWARDS project, led by Professor Ruben Valbuena, the Evidence-based knowledge and tools for decision making on adapted forest management practices project, led by Researcher Jeannette Eggers, the RESDINET project led by Researcher Langning Huo and the LANDPATHS project led by Researcher Per Sandström, were granted. Another example is that we were successful within SLU's Forest Damage Centre. All EMA flagships delivered. The support functions were both efficient and service minded. I am proud to work on our important tasks together with a team where everyone contributes!

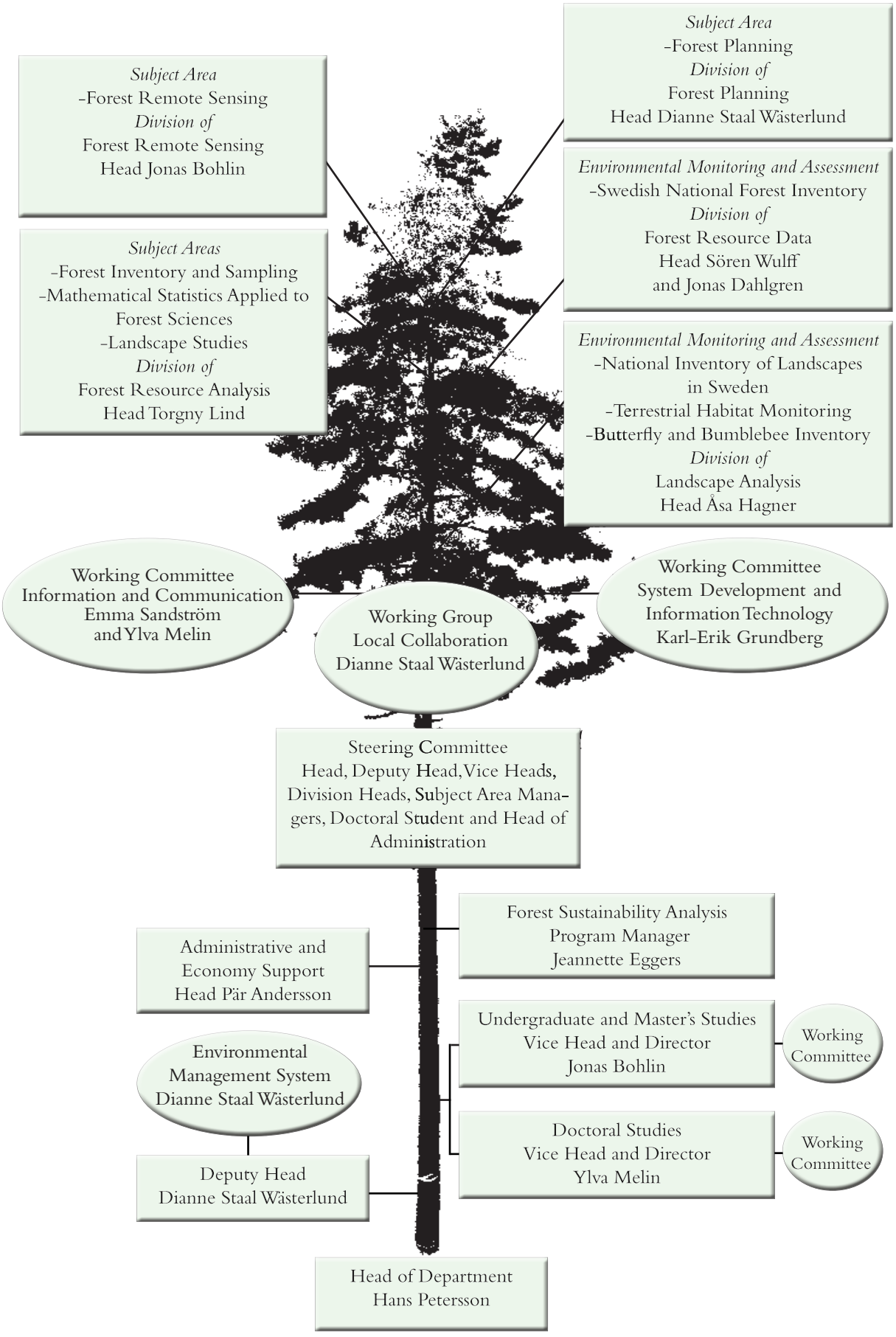
A lot happened on the personnel side:
- Ruben Valbuena was recruited as a professor at the Division of Forest Remote Sensing
- Alexandre Changenet was recruited as a postdoctoral researcher at the Division of Forest Remote Sensing
- Cameron Pellett was recruited as a doctoral student at the Division of Forest Remote Sensing
- Emanuele Papucci was recruited as a research engineer at the Division of Forest Remote Sensing
- Elias Bergström was recruited as a research assistant at the Division of Forest Remote Sensing
- Viktor Johannessen was recruited as an environmental analyst at the Division of Landscape Analysis
- Alex Appiah Mensah was recruited as a researcher at the Division of Forest Resource Analysis
- Carl Vigren was recruited as a doctoral student at the Division of Forest Resource Analysis
- Henrik Persson was recruited as a communicator at the Division of Forest Resource Analysis
- Lars Sängstuvall was recruited as an operations manager at the Division of Forest Planning
- Jonatan Årevall was recruited as system engineer at the Division of Forest Planning
- Daniel Martey Junior Mensah was recruited as a doctoral student at the Division of Forest Planning
- Lina Arnesson Ceder was recruited as a doctoral student at the Division of Forest Planning
- Ylva Jonsson was recruited as an economist at the Administrative Unit
- Patrik Isaksson was recruited as an economist at the Administrative Unit
- Linda Nalén was recruited as a human resource administrator at the Administrative Unit
- Niina Valbuena was recruited as a project coordinator at the Department
- Anders Pålsson, Tomas Lämås and Sören Wulff retired after long and loyal service.
- Cornelia Roberge was apointed Program Manager at Division of Forest Resouce Data.
- Jonas Dahlgren was apointed Head at Division of Forest Resouce Data.
- Per-Erik Wikberg was apointed Accounting Officer at Division of Forest Resouce Data.
- Hilda Mikaelsson was apointed Field Manager at Division of Forest Resouce Data.
- Leif Andersson, Lars Bengtsson, Johan Bergstedt, Ola Borin, Åke Bruhn, Stefan Callmer, Bert Carlström, Hans Davidsson, Lars Davidsson, Lennart Ivarsson, Mats Jonasson, Torgny Lind, Peter Lundin, Urban Lundin, Ingemar Olandersson, Stig-Arne Olofsson, Mikael Olsson, Jan Patek, Björn Sjöberg, Bernt Svensson, Staffan Williamsson and Hailu Zelleke were honoured with the Award for Zeal and Integrity in the Kingdoms Service for having served the government for 30 years.

We 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,
Hans Petersson
Head of Department

Organisation

Schematic View of the Department



Steering Committee Staff:

Pär Andersson
Jonas Bohlin
Pernilla Christensen
Jonas Dahlgren
Magnus Ekström
Teresa Lopez-Andujar Fustel
Åsa Hagner
Torgny Lind
Ylva Melin
Hans Petersson
Cornelia Roberge
Stefan Sandström
Göran Ståhl
Dianne Staal Wästerlund
Ruben Valbuena
Pär Wilhelmsson
Sören Wulff
Karin Öhman

Administrative and Economy Staff:

Head of Administration
Pär Andersson

Staff

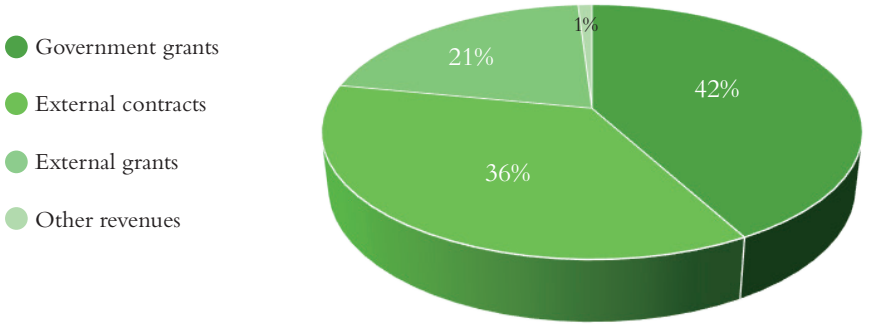
Veronika Bredberg
Thomas Fahlén
Nanna Hjertkvist
Patrik Isaksson
Ylva Jonsson
Murtaza Kaleem
Linda Nahlén
Sofia Sjögren
Oskar Thurén

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

Facts and Figures

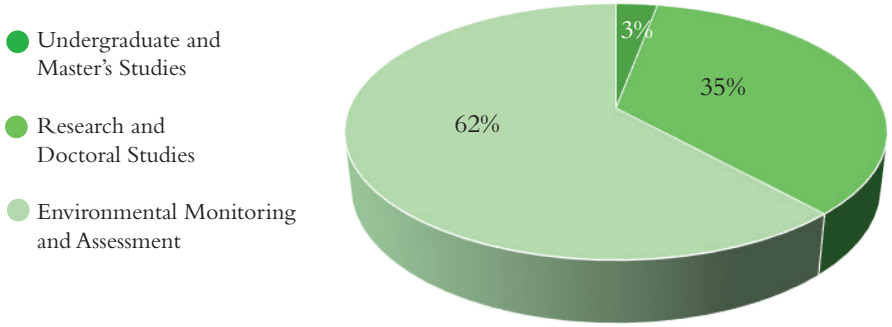
Revenues

Revenues (1000 SEK)	Undergraduate and Master's Studies	Research and Doctoral Studies	Environmental Monitoring and Assessment	Support Function	Total
Government grants	3 071	24 312	39 678	0	67 061
External contracts	713	8 099	48 752	296	57 860
External grants	553	25 355	7 492	255	33 655
Other revenues	44	1 153	1 154	0	2 351
Total	4 381	58 919	97 076	551	160 927



Costs

Costs (1000 SEK)	Undergraduate and Master's Studies	Research and Doctoral Studies	Environmental Monitoring and Assessment	Support Function	Total
Staff	2 106	32 043	56 516	8 371	99 036
Premises	406	2 894	2 429	-58	5 671
Other operative expenses	186	7 383	18 530	2 401	28 500
Depreciation	44	350	854	5	1 253
Overhead	1 280	11 097	16 555	-10 168	18 764
Total	4 022	53 767	94 884	551	153 224



Personnel Categories

Staff	Number of Work-Years★
Professors	3,9
Senior lecturers	4,1
Associate senior lecturers	0
Researchers	18,9
Postdoctoral researchers	2,4
Doctoral students	12,7
Other teachers	1,6
Administrative staff	6,2
Technical staff	33,6
Technical staff (field)	44,2
Total	127,7

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

Tables:
Ylva Jonsson, SLU
Sofia Sjögren, SLU
Figure:
Emma Sandström, SLU

External Contracts and Grants

Financier	Revenues (million SEK)
Swedish Environmental Protection Agency	35.5
Swedish Forest Agency	10.4
EU	3.5
The Foundation for Strategic Environmental Research	2.8
Formas	2.7
Swedish Board of Agriculture	2.4
Vinnova	2.3
The Royal Swedish Academy of Agriculture and Forestry	1.6
The Swedish Forest Society	1.6
Holmen Skog	1.3
Kempe Foundations	1.1
Stora Enso	1.1
Ljungberg's Foundation	1.0
Bo Rydin Foundation for Scientific Research	0.9
Swedish National Space Board	0.7
Hildur and Sven Wingquist's Foundation	0.7
Nils and Dorthi Troëdsson Foundation	0.5
Sodra	0.4
Sveaskog	0.4
County Administrative Boards	0.4
Stiftelsen Seydlitz MP bolagen	0.4
Saami Parliament	0.4
Boliden Mineral AB	0.4
Swedish Research Council	0.3
Swedish Foundation for Strategic Research	0.3
Brattås Foundation	0.3
Forestry Research Institute of Sweden	0.3
Swedish Energy Agency	0.3
Carl Trygger's Foundation	0.3
Swedish Forest-Owner Plans AB	0.3
SCA	0.3
The Church of Sweden	0.2
Norwegian Research Centre As (NORCE)	0.1
Billerudkorsnäs Skog och industri AB	0.1
Forest Science Research Foundation	0.1
Kopparfors skogar	0.1
The National Property Board of Sweden	0.1
Sida	0.1
Norwegian Institute of Bioeconomy Research (NIBIO)	0.1
Skatteverket	0.1
Others	15.6
Total	91,5

Table:Ylva Jonsson, SLU.

Vice Head and Director Undergraduate and Master's Studies
Jonas Bohlin

Undergraduate and Master's Studies

The department is a major contributor to SLU's MSc in Forestry degree programme (Jägmästarprogrammet). Our course offering amounts to about 40 ECTS credits at the undergraduate level and 50 ECTS credits at the Master's level. We offer courses in the following five subjects: remote sensing and geographic information technology (GIT); forest inventory; forest planning; mathematical statistics; and organisation and leadership. The individual courses for each subject are shown in the table below, divided into undergraduate and Master's levels.

Master's Theses

Remote Sensing

Munira, Sirajum, 2022. Transferability Analysis of Individual Tree Species Classification and Volume Estimation using Dual-Wavelength Airborne Laser Scanning in Boreal Forests.
Supervisor: Eva Lindberg

Forest Planning

Larsson, Linnea, 2022. How does an adaptation of forest management to storm damage risk affect indicators for sustainable forestry? – An analysis with Heureka PlanWise in a future with an increased risk of storm damages to forests.
Supervisor: Jeannette Eggers

Forest Inventory

Hammarlund, Fredrik, 2022. Implementering av EU:s Taxonomiförordning för svenska skogsägare EU:s rapporteringskrav för hållbara verksamheter.
Supervisor: Togny Lind

Courses

Subject	Undergraduate Level (years 1-3) 40-80 students per course	Master's Level (years 4-5) 10-60 students per course
Remote Sensing and GIS, Forest Inventory and Mathematical Statistics	Applied Remote Sensing in Forestry, 7.5 ECTS GIS and Forest Remote Sensing, 7.5 ECTS Introduction to Tree and Stand Measurement, 1 ECTS Mathematical Statistics with forest applications, 7.5 ECTS Measurement of Site Index, 1 ECTS Science theory and method 7.5 ECTS	Advanced GIT, 7.5 ECTS Forest Remote Sensing, 7.5 ECTS Remote Sensing and Forest Inventory, 15 ECTS
Forest Planning	Forest Management Planning, 4 ECTS Introduction to Forest Planning, 3.5 ECTS	
Organization and Leadership	Individual and Group Leadership, 0.3 ECTS	The Forestry from Organizational Theory Related Perspective, 15 ECTS

Text: Jonas Bohlin, SLU.
Table: Ylva Jonsson, SLU.

Doctoral Studies

Through course work, seminars and participation in focused research projects, the doctoral programme trains students how to develop and address questions within the research subjects of forest management, technology, and mathematical statistics. Within these subjects, students are supported by a team of experienced supervisors and a network of national and international experts. Additionally, the department offers the unique experience of collaboration with environmental analysts and specialists involved in two major national monitoring programmes, i.e. the Swedish National Forest Inventory and the National Inventory of Landscapes in Sweden.

During 2022 one dissertation took place at the Department.

Appiah Mensah, Alex. (2022).
Growth trends and site productivity in boreal forests under management and environmental change: insights from long-term surveys and experiments in Sweden.
Doctoral thesis.

Courses

Title	Credits	Participants	Responsible
Statistics I: Basic statistics	4.0 ECTS	6	Magnus Ekström
Statistics IV: Generalized Linear Models	4.0 ECTS	5	Magnus Ekström

Vice Head and Director Doctoral Studies
Ylva Melin

Text: Gun Lidestav, SLU.
Table: Ylva Jonsson, SLU.
Photo: Andreas Palmén.

Forest Remote Sensing

Within forest remote sensing, we work with research, education and development of remote sensing of forests and other terrestrial vegetation. We also help with the processing of remote sensing data as part of SLU's environmental monitoring and assessment. We usually utilise data from optical, laser, or radar sensors. Traditionally, sensor platforms have included satellites, aircraft and drones. Increasingly, we also use sensors placed on the ground or in vehicles to depict trees from the side.

Subject Area Manager
Ruben Valbuena

Staff
Peder Axensten
Jonas Bohlin
Mikael Egberth
Johan Holmgren
Langning Huo
Mats Högström
Jonas Jonzen
Jakob Lagerstedt
Eva Lindberg
Mats Nilsson
Kenneth Olofsson
Emanuele Papucci
Henrik Persson
Emma Sandström
Jörgen Wallerman

Postdoctoral Researcher
Christoffer Axelsson
Alexandre Changenet

Doctoral Students
Arvid Axelsson
Ivan Huuva
Ritwika Mukhopadhyay
Raul de Paula Pires
Cameron Pellett
Jon Söderberg

Guest researchers
Raul Hoffren
Niwen Li
Yining Lian
Nooshin Mashhadi
Stuart Sopp

Text:
Jonas Bohlin, SLU.

Publications

Scientific Articles

- Adnan, S.;Valbuena, R.; Kauranne, T.; Gopalakrishnan, R. & Maltamo, M. (2022). Optimizing the airborne laser scanning estimation of basal area larger than mean (BALM): An indicator of cohort balance in forests. Ecological Indicators, 142.
- Duncanson, L.; Kellner, J.R.; Armston, J. …Valbuena , R.;… (2022). Aboveground biomass density models for NASA's Global Ecosystem Dynamics Investigation (GEDI) lidar mission. Remote Sensing of Environment, 270.
- Holmgren, J.; Lindberg, E.; Olofsson, K. & Persson, H.J. (2022). Tree crown segmentation in three dimensions using density models derived from airborne laser scanning. International Journal of Remote Sensing, 43(1)299-329.
- Huo, L.; Lindberg, E. & Holmgren, J. (2022). Towards low vegetation identification: A new method for tree crown segmentation from LiDAR data based on a symmetrical structure detection algorithm (SSD). Remote Sensing of Environment, 270.
- Leite, R.V.; Silva, C.A.; Broadbent, E.N.; Amaral, C.H.; Liesenberg, V.; Almeida, D.R.A.; Mohan, M.; Godinho, S.; Cardil, A.; Hamamura, C.; Faria, B.L.; & … Valbuena, R. (2022) Large scale multi-layer fuel load characterization in tropical savanna using GEDI spaceborne lidar data. Remote Sensing of Environment, 268.
- Li, N.; Huo, L. & Zhang, X. (2022). Classification of pine wilt disease at different infection stages by diagnostic hyperspectral bands. Ecological Indicators, 142.
- Lindgren, N.; Nyström, K.; Saarela, S.; Olsson, H. & Ståhl, G. (2022). Importance of Calibration for Improving the Efficiency of Data Assimilation for Predicting Forest Characteristics. Remote Sensing, 14(18)4627.
- Lindgren, N.; Olsson, H.; Nyström, K.; Nyström, M. & Ståhl, G. (2022). Data Assimilation of Growing Stock Volume Using a Sequence of Remote Sensing Data from Different Sensors. Canadian Journal of Remote Sensing, 48(2)127-143.
- Nabuurs, G.G.; Harris, N.; Sheil, D.; Palahi, M.; Chirici, G.; Boissière, M.; Fay, C.; Reiche, J. & Valbuena, R. (2022). Glasgow forest declaration needs new modes of data ownership. Nature Climate Change, 12(5)415-417.
- Nilsson, M.B.; Laudon, H.; Lundmark, T.; Fransson, J.E.S.; Wallerman, J. & Peichl, M. (2022). Overstory dynamics regulate the spatial variability in forest-floor CO2 fluxes across a managed boreal forest landscape. Agricultural and Forest Meteorology, 318.
- Olofsson, K. & Holmgren, J. (2022). Co-registration of single tree maps and data captured by a moving sensor using stem diameter weighted linking. Silva Fennica, 56(3).
- Peichl, M.; Martinez-Garcia, E.; Fransson, J.E.S.; Wallerman, J.; Laudon, H.; Lundmark, T.& Nilsson, M. B. (2022). Landscape-variability of the carbon balance across managed boreal forests. Global Change Biology, 29(4).
- Persson, H.J.; Olofsson, K. & Holmgren, J. (2022). Two-phase forest inventory using very-high-resolution laser scanning. Remote Sensing of Environment, 271.
- Persson, H.J.; Ekström, M. & Ståhl, G. (2022). Quantify and account for field reference errors in forest remote sensing studies. Remote Sensing of Environment, 283:113302.
- Pires, R.P.; Olofsson K.; Persson, H.J.; Lindberg, E. & Holmgren, J. (2022). Individual tree detection and estimation of stem attributes with mobile laser scanning along boreal forest roads. ISPRS Journal of Photogrammetry and Remote Sensing, 187. 211-224.
- Silva, C.A.; Hudak, A.T.; Vierling, L.A.; Valbuena, R.; Cardil, A.; Mohan, M.; Alves Almeida, D.R.; Broadbent, E.N.; Zambrano, A.M.A.; Wilkinson, B.; Sharma, A.; Drake, J.B.; Medley, P.B.; Vogel, J.G.; Prata, G.A.; Atkins, J.W.; Hamamura, C.; Johnson, D.J. & Klauberg, C. (2022). Treetop: A Shiny-based application and R package for extracting forest information from LiDAR data for ecologists and conservationists. Methods in Ecology and Evolution, 13.
- Stoddart, J.; Alves de Almeida, D.R.; Silva, C.A.; Gorgens, E.B.; Keller, M. & Valbuena, R. (2022). A conceptual model for detecting small-scale forest disturbances based on ecosystem morphological traits. Remote Sensing, 14(4)933.
- Thulin, C.G.; Sorhammar, M. & Bohlin, J. (2022). Black Stork Back: Species distribution model predictions of potential habitats for Black Stork Ciconia nigra in Sweden. Ornis Svecia, 32.
- Wallin, E.; Wiberg, V.; Vesterlund, F.; Holmgren, J.; Persson, H. J. & Servin, M. (2022). Learning multiobjective rough terrain traversability. Journal of Terramechanics, 102. 17-26.
- Yu, R.; Huo, L.; Huang, H.; Yuan, Y.; Gao, B.; Liu, Y.; Yu, L.; Li, H.; Yang, L.; Ren, L.; & Luo, Y. (2022). Early detection of pine wilt disease tree candidates using time-series of spectral signatures, Frontiers in Plant Science, 13.

Forest Inventory and Sampling

Forest inventory and sampling includes general theory for sampling, field-based forest and landscape inventory, as well as related modeling and development of inventory systems that utilize multiple data sources. Today, forest inventory focuses on features related to several ecosystem services in addition to information on trees and growing stock, such as information on biological diversity and greenhouse gas balances. Within sampling, general methods are developed which also underpin important parts of the forest inventory area. The subject area contributes knowledge for a large number of applications in practical forestry and environmental monitoring.

Publications

Scientific Articles

- Asbjornsen, H.; Wang, Y.; Ellison, D.; Ashcraft, C.M.; Atallah, S.S.; Jones, K.; Mayer, A.; Altamirano, M. & Yu, P. (2022). Multi-Targeted payment for the balanced management of hydrological and other forest ecosystem services. Forest Ecology and Management, 522.
- Breidenbach, J.; Ellison, D.; Petersson, H.; Korhonen, K.; Henttonen, H.M.; Wallerman, J.; Fridman, J.; Gobakken, T.; Astrup, R. & Næsset, E. (2022). Harvested area did not increase abruptly - how advancements in satellite-based mapping led to erroneous conclusions, Annals of Forest Science, 79(2).
- Caglayan, I.; Yesil, A.; Tolunay, D. & Petersson, H. (2022). Carbon suitability mapping for forest management plan decisions: the case of Belgrad forest (Istanbul). Environmental Modeling & Assessment, 148.
- Dubayah, R.; Armston, J.; Healey, S.P.; Bruening, J.M.; Patterson, P.L.; Kellner, J.R.; Duncanson, L.; Saarela, S.; Ståhl, G.; Yang, Z.; Tang, H.; Blair, J.B.; Fatoyinbo, L.; Goetz, S.; Hancock, S.; Hansen, M.; Hofton, M.; Hurtt, G. & Luthcke, S. (2022). GEDI launches a new era of biomass inference from space. Environmental Research Letters, 17.
- Gatti, R.C.; Reich, P.B.; Gamarra, J.G.P. …Fridman, J.; …Westerlund, B;... et.al. (2022). The number of tree species on Earth, PNAS 119(6).
- Gschwantner, T.; Alberdi, I.; Bauwens, S. …Lind, T.;… et.al. (2022). Growing stock monitoring by European National Forest Inventories: Historical origins, current methods and harmonization. Forest Ecology and Management, 505.
- Guyennon, A.; Reineking, B.; Dahlgren, J.; Lehtonen, A.; Ratcliffe, S.; Ruiz-Benito, P.; Zavala, M.A. & Kunstler, G. (2022). Colonization and extinction dynamics and their link to the distribution of European trees at the continental scale. Journal of Biogeography, 49(1)117-129.
- Heiland, L.; Kunstler, G.; Ruiz-Benito, P.; Buras, A.; Dahlgren, J. & Hülsmann, L. (2022). Divergent occurrences of juvenile and adult trees are explained by both environmental change and ontogenetic effects. Ecography, 3.
- Hou, Z.; McRoberts, R.E.; Zhang, C.; Ståhl, G.; Zhao, X.; Wang, X.; Li, B.; & Xu, Q. (2022). Cross-classes domain inference with network sampling for natural resource inventory. Forest Ecosystems, 9.
- Jones, J.; Ellison, D.; Ferraz, S.; Lara, A.; Wei, X.; & Zhang, Z. (2022). Forest restoration and hydrology. Forest Ecology and Management, 520.
- Liang, J.; Gamarra, J.G.P.; Picard, N.; …Fridman, J.;…Westerlund, B.;... (2022). Co-limitation towards lower latitudes shapes global forest diversity gradients. Nature Ecology and Evolution, 6. 1423–1437.
- Mensah, A.A.; Holmström, E.; Nyström, K. & Nilsson, U. (2022). Modelling potential yield capacity in conifers using Swedish long-term experiments. Forest Ecology and Management, 512.
- Petersson, H.; Ellison, D.; Appiah Mensah, A.; Berndes, G.; Egnell, G.; Lundblad, M.; Lundmark, T.; Lundström, A.; Stendahl, J. & Wikberg, P.E. (2022). On the role of forests and the forest sector for climate change mitigation in Sweden. GCB-Bioenergy, 14(7)793-813.
- Prentius, W. & Grafström, A. (2022). Two-phase adaptive cluster sampling with circular field plots, Environmetrics, 33(5).

Book Chapters

- Lundblad, M.; Petersson, H.; Karltun, E.; Wikberg, P.E.; Stendahl, J.; Lindahl, A. & Bolinder, M. (2022). Land Use, Land-Use Change and Forestry (CRF sector 4), KP-LULUCFKP-LULUCF. In: National Inventory Report Sweden 2022 - Submitted under the United Nations Framework Convention on Climate Change. Swedish Environmental Protection Agency, pp. 360-396.
- Lundblad, M.; Petersson, H.; Karltun, E.; Wikberg, P.E.; Stendahl, J.; Lindahl, A.; & Bolinder, M. (2022). KP-LULUCF. In: National Inventory Report Sweden 2022 - Submitted under the United Nations Framework Convention on Climate Change. Swedish Environmental Protection Agency, pp. 477-502.

Subject Area Manager
Göran Ståhl

Staff
Anton Grafström
Torgny Lind
Hans Petersson

Postdoctoral Research
Indu Indirabai

Doctoral Students
Alex Appiah Mensah
Wilmer Prentius
Carl Vigren

The publication list includes articles published within the Swedish National Forest Inventory.

Text:
Göran Ståhl, SLU.

Forest Planning

Subject Area Manager
Karin Öhman

Staff
Inka Bohlin
Jeannette Eggers
Hampus Holmström
Johanna Lundström
Tomas Lämås
Ylva Melin
Eva-Maria Nordström
Thomas Nyström
Dianne Staal Wästerlund
Lars Sängstuvall
Jonatan Årevall

Doctoral Students
Lina Arnesson Ceder
Andreas Eriksson
Mathias Kristoferqvist
Teresa López-Andújar Fustel
Daniel Mensah
Patrik Ulvdal
Pär Wilhelmsson

Guest Researcher
Irene De Pellegrin Llorente

Many of the staff also work in the Forest Sustainability Analysis program.

Forest planning provides methods and tools that contribute to the sustainable use of forest resources with regard to economic, ecological and social values, and uses these in different future analysis. Our research deals with planning issues both from a forest-owner perspective and from a stakeholder or societal perspective. The research focused on the perspective of forest owners primarily concerns quantitative methods and tools used to translate the owners' objectives into forest plans in the medium and long term. The stakeholder and societal perspective is expressed in research regarding how different stakeholders can together influence the future development of the forest landscape. The focus of our future analysis is how different ecosystem services are affected over time and space by different management strategies, and the identification of optimal management under various assumptions regarding objectives and climate change.

Publications

Scientific Articles

- Eggers, J.; Lundström, J.; Snäll, T. & Öhman, K. (2022). Balancing wood production and biodiversity in intensively managed boreal forest. Scandinavian Journal of Forest Research, 37(3)213-225.
- Filyushkina, A.; Widenfalk, L.A.; Nordström, E.M.; Laudon, H. & Ranius, T. (2022). Expert assessment of landscape-level conservation strategies in boreal forests for biodiversity, recreation and water quality. Journal for Nature Conservation, 67.
- Hallberg-Sramek, I.; Reimerson, E.; Priebe, J.; Nordström, E.M.; Marald, E.; Sandstroem, C. & Nordin, A. (2022). Bringing "Climate-Smart Forestry" Down to the local level-identifying barriers, pathways and indicators for its implementation in practice, Forests, 13(1)98.
- Jonsson, A.; Elfving, B.; Hjelm, K.; Lämås, T.; & Nilsson, U. (2022). Will intensity of forest regeneration measures improve volume production and economy? Scandinavian Journal of Forest, 37(3)200-212.
- Jonsson, R.; Woxblom, L.; Björheden, R.; Nordström, E.M; Blagojevic, B. & Lindroos, O. (2022). Analysis of decision-making processes for strategic technology investments in Swedish large-scale forestry. Silva Fennica, 56(3).
- Mazziotta, A.; Lundström, J.; Forsell, N.; Moor, H.; Eggers, J.; Subramanian, N.; Aquilue, N.; Moran-Ordonez, A.; Brotons, L. & Snäll, T. (2022). More future synergies and less trade-offs between forest ecosystem services with natural climate solutions instead of bioeconomy solutions. Global Change Biology, 28(21) 6333-6348.
- Mattsson, E.; Erlandsson, M.; Karlsson, P.E. & Holmström, H. (2022). A conceptual landscape-level approach to assess the impacts of forestry on biodiversity. Sustainability, 14(7)4214.
- Moor, H. Eggers, J.; Fabritius, H.; Forsell, N.; Henckel, L.; Bradter, U.; Mazziotta, A.; Norden, J. & Snäll, T. (2022). Rebuilding green infrastructure in boreal production forest given future global wood demand. Journal of Applied Ecology, 59(6)1659-1669.
- Ulvdal, P.; Öhman, K.; Eriksson, O.; Staal Wästerlund, D. & Lämås, T. (2022). Handling uncertainties in forest information: the hierarchical forest planning process and its use of information at large forest companies. Forestry, 96(1)62-75.
- Wilhelmsson, P.; Lämås, T.; Wallerman, J.; Eggers, J. & Öhman, K. (2022). Improving dynamic treatment unit forest planning with cellular automata heuristics. European Journal of Forest Research, 141. 887-900.

Text:
Karin Öhman, SLU.
Photo: Anton Larsson, SLU.

Mathematical Statistics Applied to Forest Sciences

The application of mathematical and statistical methods in forest sciences is challenging due to the great amount of variations present in nature, with complex dynamics that involve variations in both time and space. A wide range of mathematical-statistical methods is studied, developed and applied for collecting, analysing, interpreting and presenting empirical data. Such methods make it possible to draw conclusions based on empirical data and can be used for description, decision-making and prediction within the forest sciences.

Publications

Scientific Articles

- Angelov, A.G. & Ekström, M. (2022). Tests of stochastic dominance with repeated measurements data. AStA Advances in Statistical Analysis, DOI: 10.1007/s10182-022-00446-8
- Angelov, A.G.; Ekström, M.; Puzon, K.; Arcenas, A. & Kriström, B. (2022) Quantile regression with interval-censored data in questionnaire-based studies. Computational Statistics, DOI: 10.1007/s00180-022-01308-2.
- Esseen, P.A.; Ekström, M.; Grafström, A.; Jonsson, B.G.; Palmqvist, K.; Westerlund, B. & Ståhl, G. (2022). Multiple drivers of large-scale lichen decline in boreal forest canopies. Global Change Biology, 28(10)3293-3309.
- Gonzalez, N.; Svenson, O.; Ekström, M.; Kriström, B. & Nilsson, M.E. (2022). Self-selected interval judgments compared to point judgments: A weight judgment experiment in the presence of the size-weight illusion, PLOS ONE 17(3):e0264830.
- Saarela, S.; Holm, S.; Healey, S.P.; Patterson, P.L.; Yang, Z.; Andersen, H.E.; Dubayah, R.; Qi, W.; Duncanson, L.; Armston, J.D.; Gobakken, T.; Næsset, E.; Ekström M. & Ståhl, G. (2022). Comparing frameworks for biomass prediction for the Global Ecosystem Dynamics Investigation. Remote Sensing of Environment, 2781: 113074.

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The publication list includes articles published within the NILS, THUF and FHIN programs.

Through an interdisciplinary approach, landscape studies research focuses on the utilisation of landscapes, their multiple resources and their users. Through this research, we contribute to an increased understanding of the socioecological processes and how they change over time and in space. The connections between natural resource use, stewardship, ecosystem production and community development processes are of special interest. Our work builds upon capacities within environmental monitoring, forest impact assessment and work science, including gender studies, policy, and rural development studies.

Publications

Scientific Articles

- Andersson, E.; & Johansson, K. (2022). Organisational learning in gender mainstreaming: openings and barriers for implementation and change. International Journal of Learning and Change, 14(3)339-355.
- Johansson, K.; Andersson, E.; & Johansson, M. (2022). Restructuring masculinities and reshaping inequalities: Negotiations of (gendered) sales work and relations in an industrial organization. Gender Work & Organization.
- Roos, U.; Lidestav, G.; Sandström, S.; & Sandström, P. (2022). Samråd: an institutional arrangement in the context of forestry and reindeer husbandry in northern Sweden. International Forestry Review, 24(3)441-457.
- Skarin, A.; Brandao Niebuhr Dos Santos, B.; Sandström, P.; & Tommervik, H. (2022). Den ekologiska bevisföringen i Fosenmålet : analys av renens användning av vinterbetesmarkerna och konsekvenser av vindkraftutbyggnad. Utmark, 1. 19-27.
- Tommervik, H.; Skarin, A.; Brandao Niebuhr Dos Santos, B.; & Sandström, P. (2022). Beregning av tapt beite etter utbygging av vindkraftverk samt kraftlinjer på Fosen. Utmark, 1. 28-40.

Book Chapters

- Cambou, D.; Sandström, P.; Skarin, A. & Borg, E. (2022). Reindeer husbandry vs. wind energy: analysis of the Pauträsk and Norrback court decisions in Sweden. Routledge Research in Polar Regions, pp. 39-58. Book title: Indigenous Peoples, Natural Resources and Governance: Agencies and Interactions, ISBN: 978-0-367-67415-1, eISBN: 978-1-003-13127-4
- Horstkotte, T.; Kumpula, J.; Sandström, P.; Tommervik, H.; Kivinen, S.; Skarin, A.; Moen, J. & Sandström, S. (2022). Pastures under pressure : Effects of other land users and the environment. Earthscan Studies in Natural Resource Management, pp. 76-98. Book title: Reindeer Husbandry and Global Environmental Change: Pastoralism in Fennoscandia; ISBN: 978-0-367-63267-0, eISBN: 978-1-003-11856-5

Text: Gun Lidestav, SLU.
Photo: Anton Larsson, SLU.

Environmental Monitoring and Assessment

SLU is unique among Swedish universities with its strong focus on environmental monitoring and assessments (EMA). Within SLU, our department is also unique, as EMA is the dominating activity (roughly 60 per cent of the budget). For a large set of terrestrial variables, EMA is the long-term monitoring and assessment of stocks and changes in stocks. EMA includes data capture, analysis and reporting. Inventories in the field, remote sensing, or a combination of these two methods, are performed using area-based sampling designs adapted mainly to regional or larger scales. The idea is to carefully measure variables on the sample units, meaning that most of the uncertainty should arise from the fact that only a sample and not the entire population is measured. The uncertainty of estimates can be controlled by an efficient design and a large sample, and it is possible to predict the accuracy of the estimates. EMA is an efficient way to monitor "how much" without disturbing the population, while an experimental design focuses on explaining "why" in a well-defined manipulated area. Projections and scenarios about the future of terrestrial variables, often based on data from the monitoring programmes, are also considered part of EMA activities.

Head
Environmental Monitoring and Assessment
Hans Petersson

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Swedish National Forest Inventory

SLU is the authority responsible for national official statistics in the area of forest status and change. Statistical products consist of area conditions, growing stock and tree biomass, annual growth, vegetation and habitat conditions, and forest damage. The Swedish National Forest Inventory (NFI) operates within the department to fulfil SLU's statistical responsibility. Through an annual field survey of sample plots spread across the entire country, data are collected for compilation and presentation of official statistics. The results are published annually in the publication *Skogsdata*, which can be downloaded in pdf format from our website. All official statistics are also available for download from our website in multiple formats, including APIs.

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National Inventories of Landscapes in Sweden

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Many of the staff also work in the THUF and FHIN programs.

Text: Henrik Hedenås, SLU.

The National Inventories of Landscapes in Sweden (NILS) aim to collect, analyze, and present comprehensive data on the state and changes of the Swedish nature over time. The inventories focuses primarily on alpine mountainous regions, grasslands, old deciduous forests, and seashores. One of the key uses of the data collected is to report on the area and quality of habitats listed in Annex 1 of the EU's Habitat Directive, which is reported to the EU. Furthermore, our data is used to monitor progress towards the Swedish Environmental Objectives and to develop national land cover data.

These inventories cover a wide range of natural phenomena, including both common and uncommon types. To tackle the challenge of inventorying such a diverse range of nature, a new sampling design has been developed. This sampling design enables us to tailor the inventories to specific factors, such as the frequency of the sought-after habitats, regional requirements, and technological advances. The Swedish Environmental Protection Agency and the Swedish Board of Agriculture commission our inventories.

NILS is a national environmental monitoring program that gathers multiple inventories.

NILS Grassland inventory

A national inventory of all types of grassland but with extra emphasis on grasslands with high nature values (designated in Annex 1 of the EU's Habitat Directive).

NILS Deciduous forest inventory

A national inventory of old deciduous forests that complements data from the National Forest Inventory. The focus is on Quercus, Fagus, Tilia, Acer, Fraxinus, or Ulmus rich forests i.e. broad-leaf forests, swamp deciduous forests, alluvial deciduous forests and other old deciduous forests.

NILS Alpine mountain inventory

A national inventory of the alpine area but with a focus on nature types with high nature values (designated in Annex 1 of the EU's Habitat Directive).

THUF Seashore inventory

A national inventory of the Swedish coast and archipelago, with a focus on habitats included in Annex 1 of the EU's Habitat Directive. The inventory started in 2012.

FHIN Butterfly and bumblebee inventory

Nationwide long-term monitoring of semi-natural grasslands to detect changes in biodiversity quality. Data contribute to the evaluation of the environmental objective A Varied Agricultural Landscape.

NILS Initial Inventory 2003-2020

The purpose of the initial inventory was to monitor biodiversity in all terrestrial environments in Sweden, to follow changes in the everyday landscape. An important part of the program was to study changes in landscape composition and structure that may affect biodiversity.

All parts of the inventories are integrated within NILS with cooperation within administration, analysis, data flows, aerial inventory, field personnel, and training. This provides synergies and reduces the costs of each individual inventory. Data from the inventories are open.

Forest Sustainability Analysis

Program Manager
Jeannette Eggers

Many of the staff in Forest planning also work in the Forest sustainability analysis program.

Text: Johanna Lundström, SLU.

The Forest Sustainability Analysis (SHa) programme works with qualitative and quantitative analyses of the potential of forest ecosystems to provide various forms of ecosystem services in the long term. Through the programme, policy-makers, decision-makers and planners within a range of sectors in society, e.g. forestry, environment and energy, have access to expertise, analytical tools and decision support for issues related to forest development. The Heureka decision-support system is a central tool in most SHa analyses.

Field Staff

Every year, the department organises and implements extensive inventories of forests and landscapes in Sweden. To conduct this work, we employ a number of field workers.

Swedish National Forest Inventory

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