Department of
Forest Resource Management

Annual Report 2023

Dear Reader,

Contents

Cover photo:
Åke Bruhn, SLU.
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Hans Petersson, SLU.
Editor and Layout:
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 the year and cannot account for everything. The department was involved in several government assignments and a delegation from the government visited us in October. Many grant applications were made on both the research side and the EMA-side. For example, the Mistra Digital Forest phase two project, led by docent Johan Holmgren, TRANSFORMIT and MoniFun, led by professor Ruben Valbuena, Detecting early warning signs of drought stress in trees, led by professor Ruben Valbuena and Developing hyperspectral drone imagery for improved monitoring of forest insect damages, led by Langning Huo, were granted. 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:

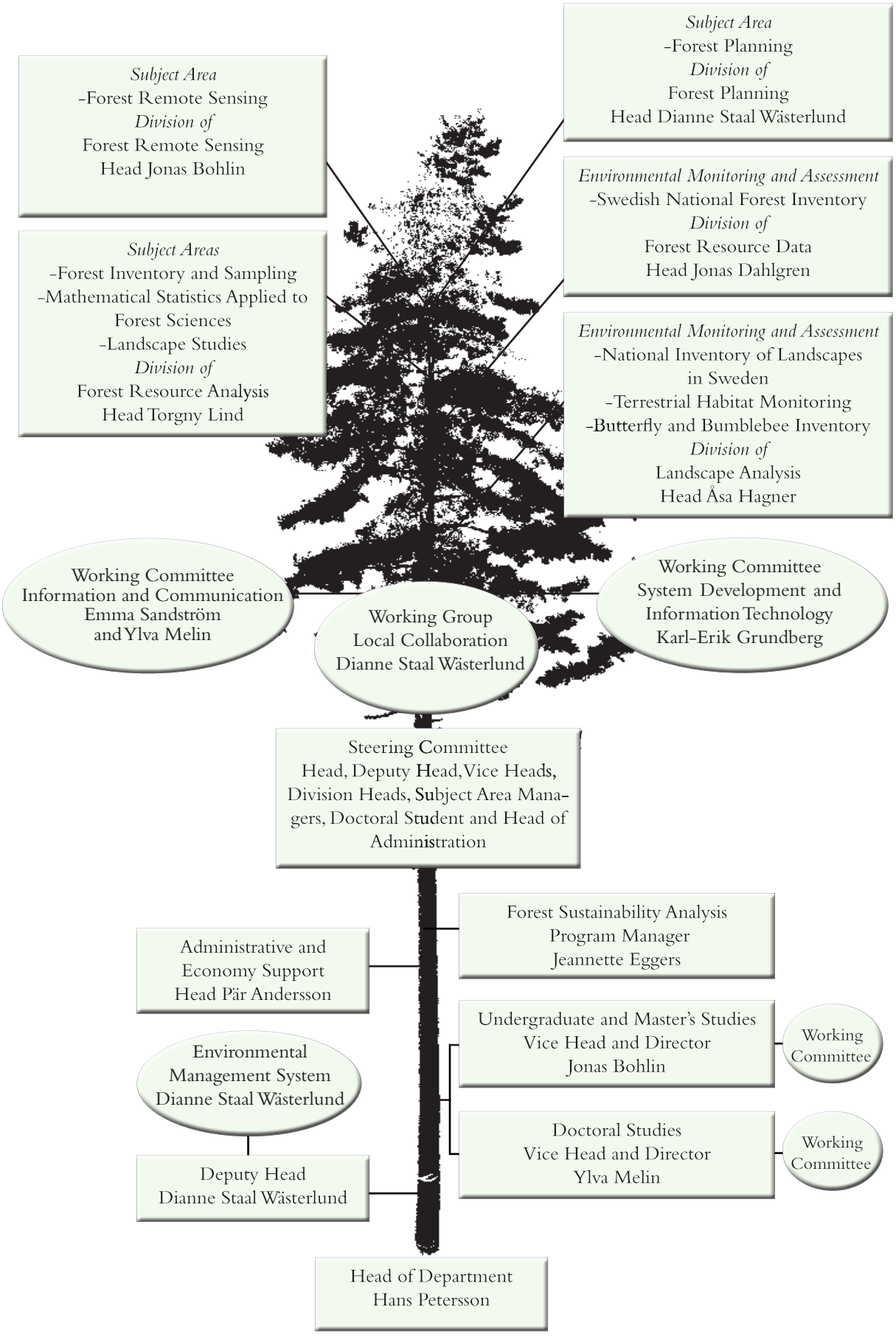
- Christoffer Axelsson, Victor Manabe and Xiaoming Wang were recruited as research engineers at the Division of Forest Remote Sensing
- Louisa Eurich was recruited as a doctoral student at the Division of Forest Remote Sensing
- Lina Wikander was recruited as an environmental assessment specialist at the Division of Landscape Analysis
- Miriam Markström was recruited as an environmental assessment specialist at the Division of Forest Resource Data
- Emma Heinerud and Johanna Lindström were recruited as research assistants at the Division of Forest Resource Data
- Magnus Ekström was recruited as a senior advisor at the Division of Forest Resource Analysis
- Emanuele Papucci and Mateusz Grzeszkiewicz were recruited as a doctoral students at the Division of Forest Resource Analysis
- Teresa Aschenbrenner was recruited as a research assistant at the Division of Forest Resource Analysis
- Jonathan Årevall was recruited as an operational manager at the Division of Forest Planning
- Sofia Koistinen Edlund and Jessica Wallström were recruited as personnel administrators at the Administrative Unit
- Inka Bohlin was appointed senior lecturer at the Division of Forest Planning
- Mats Högström and Björn Nilsson retired after long and loyal service
- Åsa Hagner and Per Sandström 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
Karin Öhman

Administrative and Economy Staff:

Head of Administration
Pär Andersson

Staff

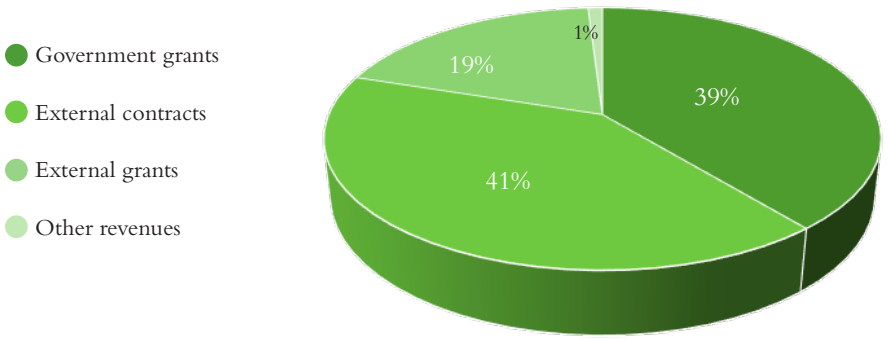
Nanna Hjertkvist
Patrik Isaksson
Ylva Jonsson
Sofia Koistinen Edlund
Linda Nahlén
Veronika Resolut
Sofia Sjögren
Jessica Wallström

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	3 835	19 046	39 440	0	62 321
External contracts	299	4 779	60 458	439	65 975
External grants	378	28 174	961	256	29 769
Other revenues	0	1 150	1 179	0	2 329
Total	4 512	53 149	102 039	695	160 395



Costs

Costs (1000 SEK)	Undergraduate and Master's Studies	Research and Doctoral Studies	Environmental Monitoring and Assessment	Support Function	Total
Staff	2 629	35 073	57 916	9 373	104 991
Premises	542	3 185	2 392	-104	6 016
Other operative expenses	-30	6 691	23 484	2 308	32 453
Depreciation	-22	728	603	4	1 312
Overhead	1 680	12 507	16 876	-10 886	20 177
Total	4 799	58 185	101 271	695	164 949

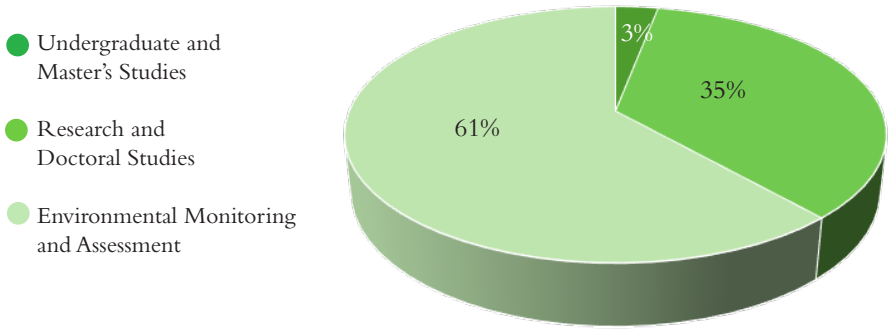


Table:
Ylva Jonsson, SLU.
Figure:
Emma Sandström, SLU.

External Contracts and Grants

Financier	Revenues (million SEK)
Swedish Environmental Protection Agency	40.4
Formas	5.8
Swedish Forest Agency	4.8
EU	4.5
The Foundation for Strategic Environmental Research	4.0
Vinnova	3.6
Swedish Board of Agriculture	2.6
Bo Rydin Foundation for Scientific Research	1.9
Hildur and Sven Wingquist's Foundation	1.5
Swedish Foundation for Strategic Research	1.5
Kempe Foundations	1.1
The Swedish Forest Society	1.0
Stora Enso skog AB	0.6
Sveaskog	0.5
The Royal Swedish Academy of Agriculture and Forestry	0.4
Carl Trygger's Foundation	0.4
Forestry Research Institute of Sweden	0.4
Ljungberg's Foundation	0.3
Government Offices of Sweden	0.3
Swedish Forest-Owner Plans AB	0.3
SCA	0.3
Saami Parliament	0.2
Brattås Foundation	0.2
Norwegian Institute of Bioeconomy Research (NIBIO)	0.2
Statistics Sweden	0.2
Nils and Dorthi Troedsson Foundation	0.2
Swedish Research Council	0.2
Holmen Forest	0.1
Billerud	0.1
Kopparfors Forest	0.1
Sodra	0.1
Uppsala Dioceses	0.1
The National Property Board of Sweden	0.1
The Church of Sweden	0.1
Sida	0.1
Others	17.6
Total	95,7

Personnel Categories

Staff	Number of Work-Years★
Senior advisor	0.9
Professors	2.9
Senior lecturers	4.0
Associate senior lecturers	0
Researchers	19.0
Postdoctoral researchers	1.0
Doctoral students	15.2
Other teachers	1.6
Administrative staff	8.2
Technical staff	37.9
Technical staff (field)	40.8
Total	131,5

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

Table:Ylva Jonsson, SLU, Sofia Koistinen Edlund, SLU, Linda Nalén, SLU.

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

Undergraduate and Master's Studies

The department is a large contributor to the undergraduate and master education within the forest faculty. Our education in forest mensuration, forest modelling and forest planning are core topics in the university's responsibility of being a sector university for forestry. Therefore we are largely involved in the BSc and MSc programs in forestry but also other programs within the university. Our course offering amounts to about 80 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

Bergström Elias, 2023. Drone images and AI for estimating stand volume and tree species proportion Applied on high-resolution low overlap orthophotos. Supervisor: Jonas Bohlin

Forslöw Erik 2023. Estimating basal area weighted mean height and stem volume by using data from stereo-matched drone imagery through pre-existing models from Skogliga grunddata. Supervisor: Jonas Bohlin

Forest Planning

De Prins Freja, 2023. Knowledge Management (KM) for managing fungal. Supervisor: Dianne Staal Wästerlund

Kinnunen Moa, 2023. Alternative stand-adapted management and intensive management in Norra Skog's service Forest owner strategy – analysis with Heureka. Supervisor: Lars Sängstuvall

Sandberg Anna, 2023. Relationship-building meetings: What private forest owners expect in meetings with timber buyers. Supervisor: Dianne Staal Wästerlund

Skoglund Olof, 2023. Consequence analyzes of forest management on low productive peatlands - from a forest owner's perspective. Supervisor: Lars Sängstuvall

Forest Inventory

Folkeson Linn, 2023. Evaluation of the reliability of growth models when simulating the development of unmanaged forest in Sweden. Supervisor: Torgny Lind

Jancelewicz Julia, 2023. Gender within Polish public forestry sector A case study on State Forest Holding. Supervisor: Elias Andersson

Lomander Axel, 2023. Effects of forest management that promotes ground lichens in low productive sites. Supervisor: Torgny Lind

Åkersten Jacob, 2023. Evaluation of mobile applications for forest inventory. Supervisor: Göran Ståhl

Courses

Subject	Undergraduate Level (years 1-3) 40 students per course	Master's Level (years 4-5) 15 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 Mathematical Statistics with Forest Applications, 7.5 ECTS Science Theory and Method, 7.5 ECTS	Forest Remote Sensing, 7.5 ECTS Geographic Information Technology II, 7.5 ECTS Remote Sensing and Forest Inventory, 15 ECTS
Forest Planning	Forest Planning, 15 ECTS Forest Planning with PlanWise as Decision Support, 7.5 ECTS Planning and Analyses of Forest Ecosystem Services, 7,5 ECTS Planning and Analyses with the Heureka System - a Forest Decision Support System, 15 ECTS	Forest Sustainability Analysis, 7.5 ECTS
Organization and Leadership	Gender Competence for the Forestry Sector, 7.5 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.

Vice Head and Director
Doctoral Studies
Ylva Melin

Doctoral Theses

Doctorate - Forest Remote Sensing

Arvid Axelsson
Tree Species Classification: Analyzing Multitemporal Satellite Imagery and Multispectral Airborne Laser Scanning Data. Acta Universitatis Agriculturae Sueciae.

Doctorate - Forest Remote Sensing

Ivan Huuva
Estimation of change in forest variables using synthetic aperture radar. Acta Universitatis Agriculturae Sueciae.

Doctorate - Forest Inventory and Sampling

Wilmer Prentius
Contributions to the Theory of Environmental Sampling. Acta Universitatis Agriculturae Sueciae.

Doctorate - Forest Planning

Pär Wilhelmsson
Forest planning utilizing high spatial resolution data. Acta Universitatis Agriculturae Sueciae.

Courses

Title	Credits	Participants	Responsible
Considering Uncertainty in Forest Management Planning	4.5 ECTS	12	Irene Pellegrin and Dianne Staal Wästerlund
Modelling of the forest landscape dynamics with help of an advanced decision support system	3.0 ECTS	11	Karin Öhman
Statistics I: Basic statistics	4.0 ECTS	8	Magnus Ekström
Statistics III: Regression analysis	4.0 ECTS	12	Magnus Ekström

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
Christoffer Axelsson
Peder Axensten
Jonas Bohlin
Wei-Ling Chen
Mikael Egberth
Johan Holmgren
Langning Huo
Mats Högström
Jonas Jonzen
Jakob Lagerstedt
Eva Lindberg
Victor Manabe
Mats Nilsson
Kenneth Olofsson
Emanuele Papucci
Henrik Persson
Emma Sandström
Niina Valbuena
Jörgen Wallerman
Xiaoming Wang

Postdoctoral Researcher
Alexandre Changenet

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

Guest Doctoral Students/Researchers
Marine Cambon
Nooshin Mashhadi
Marius Rüetschi
Stuart Sopp
Run Yu

Text:
Jonas Bohlin, SLU.

Publications

Scientific Articles

- Axelsson, C.R., Lindberg, E., Persson, H. J., and Holmgren, J. (2023) The use of dual-wavelength airborne laser scanning for estimating tree species composition and species-specific stem volumes in a boreal forest, International Journal of Applied Earth Observation and Geoinformation, 10.1016/j.jag.2023.103251
- García-Cimarras, A., Manzanera, J.A., and Valbuena, R. (2023) LiDAR Scan Density and Spatial Resolution Effects on Vegetation Fuel Type Mapping, Croatian Journal of Forest Engineering, 10.5552/crojfe.2023.1689
- Gebresenbet, G., Bosona, T., Patterson, D., Persson, H.J., Fischer, B.M.C., Mandaluniz, N., Chirici, G., Zacepins, A., Komasilovs, V., Pitulac, T., and Nasirahmadi, A. (2023) A concept for application of integrated digital technologies to enhance future smart agricultural systems, Smart agricultural technology, 10.1016/j.atech.2023.100255
- Goodbody, T.R.H., Coops, N.C., Queinnec, M., White, J.C., Tompalski, P., Hudak, A.T., Auty, D., Valbuena, R., LeBoeuf, A., Sinclair, I., McCartney, G., Prieur, J-F., and Woods, M.E. (2023) sgsR: a structurally guided sampling toolbox for LiDAR-based forest inventories, Forestry: An International Journal of Forest Research, 10.1093/forestry/cpac055
- Gonzalez, A., ...Valbuena, R., ... and Torrelio, C.Z. (2023) A global biodiversity observing system to unite monitoring and guide action, Nature Ecology & Evolution, 10.1038/s41559-023-02171-0
- Huo, L., Lindberg, E., Bohlin, J., and Persson, H. J. (2023) Assessing the detectability of European spruce bark beetle green attack in multispectral drone images with high spatial- and temporal resolutions, Remote Sensing of Environment, 10.1016/j.rse.2023.113484
- Huo, L., Strengbom, J., Lundmark, T., Westerfelt, P., and Lindberg, E. (2023) Estimating the conservation value of boreal forests using airborne laser scanning, Ecological Indicators, 10.1016/j.ecolind.2023.109946
- Huuva, I., Wallerman, J., Fransson, J.E.S., and Persson, H.J. (2023) Prediction of Site Index and Age Using Time Series of TanDEM-X Phase Heights, Remote Sensing, 10.3390/rs15174195
- Karvemo, S., Huo, L., Öhrn, P., Lindberg, E., and Persson, H.J. (2023) Different triggers, different stories: Bark-beetle infestation patterns after storm and drought-induced outbreaks, Forest Ecology and Management, 10.1016/j.foreco.2023.121255
- Larson, J., Wallerman, J., Peichl, M., and Laudon, H. (2023) Soil moisture controls the partitioning of carbon stocks across a managed boreal forest landscape, Scientific Reports, 10.1038/s41598-023-42091-4
- Latifi, H., Valbuena, R., and Silva, C.A. (2023) Towards complex applications of active remote sensing for ecology and conservation, Methods in Ecology and Evolution, 10.1111/2041-210X.14154
- Mukhopadhyay, R., Naesset, E., Gobakken, T., Mienna, I.M., Bielza, J.C., Austrheim, G., Persson, H.J., Orka, H.O., Roald, B-E., Bollandsas, O.M. (2023) Mapping and Estimating Aboveground Biomass in an Alpine Treeline Ecotone under Model-Based Inference, Remote Sensing, 10.3390/rs15143508
- Olofsson, K., and Holmgren, J. (2023) Stem Quality Estimates Using Terrestrial Laser Scanning Voxelized Data and a Voting-Based Branch Detection Algorithm, Remote Sensing, 10.3390/rs15082082
- Peichl, M., Martinez-Garcia, E., Fransson, J.E.S., Wallerman, J., Laudon, H., Lundmark, T., and Nilsson, M.B. (2023) On the uncertainty in estimates of the carbon balance recovery time after forest clear-cutting, Global Change Biology, 10.1111/gcb.16772
- Peng, X., Jiang, S.C., Liu, S.G., Valbuena, R., Smith, A., Zhan, Y., Shi, Y., Ning, Y., Feng, S.L., Gao, H.Q., and Wang, Z. (2023) Long-term satellite observations show continuous increase of vegetation growth enhancement in urban environment, Science of the Total Environment, 10.1016/j.scitotenv.2023.165515
- Sopp, S., and Valbuena, R. (2023) Vascular Optimality Dictates Plant Morphology away from Leonardo's Rule, Proceedings of the National Academy of Sciences of the United States of America (PNAS) 10.1073/pnas.2215047120
- Scheeres, J., ...Valbuena, R., ... and de Almeida, D.R.A. (2023) Distinguishing forest types in restored tropical landscapes with UAV-borne LIDAR, Remote Sensing of Environment, 10.1111/rec.13890
- Stoddart, J., Suarez, J., Mason, W., and Valbuena, R. (2023) Continuous Cover Forestry and Remote Sensing: A Review of Knowledge Gaps, Challenges, and Potential Directions, Current Forestry Reports, 10.1007/s40725-023-00206-0
- Turubanova, S., ...Valbuena, R., ... and Stolle, F. (2023) Tree canopy extent and height change in Europe, 2001-2021, quantified using Landsat data archive, Remote Sensing of Environment, 10.1016/j.rse.2023.113797

Book Chapter

- Nilsson, M., Ardo, J., Söderström, M., Allard, A., Brown, A., and Webber, L. (2023) Remote sensing and Earth observation systems, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-7

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

- Appiah Mensah, A., Petersson, H., Dahlgren, J., and Elfving, B. (2023) Taller and slenderer trees in Swedish forests according to data from the National Forest Inventory, Forest Ecology and Management, 10.1016/j.foreco.2022.120605
- Appiah Mensah, A., Jonzen, J., Nyström, K., Wallerman, J., and Nilsson, M. (2023) Mapping site index in coniferous forests using bi-temporal airborne laser scanning data and field data from the Swedish national forest inventory, Forest Ecology and Management, 10.1016/j.foreco.2023.121395
- Araza, A., ...Fridman, J., ... and Hein, L. (2023) Past decade above-ground biomass change comparisons from four multi-temporal global maps, International Journal of Applied Earth Observation and Geoinformation, 10.1016/j.jag.2023.103274
- Bassett, K.R., Östlund, L., Gundale, M.J., Fridman, J., and Jamtgard, S. (2023) Forest inventory tree core archive reveals changes in boreal wood traits over seven decades, Science of the Total Environment, 10.1016/j.scitotenv.2023.165795
- Bullock, E. L., ...Ståhl, G., ... and Dubayah, R. (2023) Estimating aboveground biomass density using hybrid statistical inference with GEDI lidar data and Paraguay's national forest inventory, Environmental Research Letters, 10.1088/1748-9326/acdf03
- Chen, F., Hou, Z., Saarela, S., McRoberts, R.E., Ståhl, G., Kangas, A., Packalen, P., Li, B., and Xu, Q. (2023) Leveraging remotely sensed non-wall-to-wall data for wall-to-wall upscaling in forest inventory, International Journal of Applied Earth Observation and Geoinformation, 10.1016/j.jag.2023.103314
- Dib, V., ...Ellison, D., ... and Strassburg, B. (2023) Shedding light on the complex relationship between forest restoration and water services, 10.1111/rec.13890
- Engel, M., Mette, T., Falk, W., Poschenrieder, W., Fridman, J., and Skudnik, M. (2023) Modelling Dominant Tree Heights of Fagus sylvatica L. Using Function-on-Scalar Regression Based on Forest Inventory Data, 10.3390/f14020304
- Guyennon, A., ...Dahlgren, J., ... and Kunstler, G. (2023) Modelling Dominant Tree Heights of Fagus sylvatica L. Using Function-on-Scalar Regression Based on Forest Inventory Data, Forests, 10.3390/f14020304
- Hou, Z., Yuan, K., Ståhl, G., McRoberts, R.E., Kangas, A., Tang, H., Jiang, J., Meng, J., Xu, Q., and Li, Z. (2023) Conjugating remotely sensed data assimilation and model-assisted estimation for efficient multivariate forest inventory, Remote Sensing of Environment, 10.1016/j.rse.2023.113854
- Lee, D., Holmström, E., Hynynen, J., Nilsson, U., Korhonen, K.T., Westerlund, B., Bianchi, S., Aldea, J., and Huuskonen, S. (2023) Current state of mixed forests available for wood supply in Finland and Sweden, Scandinavian Journal of Forest Research, 10.1080/02827581.2023.2259797
- Ma, H.Z., … …Fridman J., … … Westerlund, B.,… and Constantin M. (2023) The global biogeography of tree leaf form and habit, Nature Plants, 10.1038/s41477-023-01543-5
- McRoberts, R.E., Naesset, E., Hou, Z., Ståhl, G., Saarela, S., Esteban, J., Travaglini, D., Mohammadi, J., and Chirici, G. (2023) How many bootstrap replications are necessary for estimating remote sensing-assisted, model-based standard errors?, Remote Sensing of Environment, 10.1016/j.rse.2023.113455
- Paivinen, R., Astrup, R., Birdsey, R.A., Breidenbach, J., Fridman, J., Kangas, A., Kauppi, P. E., Kohl, M., Korhonen, K.T., Johannsen, V., Morneau, F., Riedel, T., Schadauer, K., and Wernick, I.K. (2023) Ensure forest-data integrity for climate change studies, Nature Climate Change, 10.1038/s41558-023-01683-8
- Prentius, W. (2023) Locally correlated Poisson sampling, Environmetrics, 10.1002/env.2832
- Ramezani, H., and Lister, A. (2023) Effects of cluster plot design parameters on landscape fragmentation estimates: A case study using data from the Swedish national forest inventory, Applied Geography, 10.1016/j.apgeog.2023.103045
- Ramezani, H., and Nazariani, N. (2023) A Theoretical Development and Field Test of a Horizontal Line Sampling (HLS) in Coppice Forests, Austrian journal of forest science, 10.53203/fs.2302.1
- Saarela, S., Varvia, P., Korhonen, L., Yang, Z., Patterson, P-L., Gobakken, T., Næsset, E., Healey, S.P., and Ståhl., G. (2023) Three-phase hierarchical model-based and hybrid inference, MethodsX, 10.1016/j.mex.2023.102321
- Strimbu, V.F., Naesset, E., Orka, H.O., Liski, J., Petersson, H., and Gobakken, T. (2023) Estimating biomass and soil carbon change at the level of forest stands using repeated forest surveys assisted by airborne laser scanner data, Carbon Balance and Management, 10.1186/s13021-023-00222-4

Book Chapter

- Lundblad, M., Petersson, H., Karltun, E., Wikberg, P-E., Stendahl, J., Lindahl, A., and Bolinder, M. (2023). Land Use, Land-Use Change and Forestry (CRF sector 4). In: National Inventory Report Sweden 2023 - Submitted under the United Nations Framework Convention on Climate Change. Swedish Environmental Protection Agency

Subject Area Manager
Göran Ståhl

Staff
Alex Appiah Mensah
Anton Grafström
Torgny Lind
Hans Petersson

Doctoral Students
Mateusz Grzeszkiewicz
Emanuele Papucchi
Wilmer Prentius
Carl Vigren

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

Text:
Göran Ståhl, SLU.

Subject Area Manager
Karin Öhman

Staff
Inka Bohlin
Jeannette Eggers
Hampus Holmström
Johanna Lundström
Tomas Lämås
Ylva Melin
Eva-Maria Nordström
Dianne Staal Wästerlund
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.

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

Forest Planning

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

- Bakx, T.R.M., Trubins, R., Eggers, J., and Akselsson, C. (2023) The effect of spatial and temporal planning scale on the trade-off between the financial value and carbon storage in production forests, Land Use Policy, 10.1016/j.landusepol.2023.106583
- Blagojevic, B., Nordström, E-M., and Lindroos, O. (2023) A framework for defining weights of decision makers in group decision-making, using consistency between different multicriteria weighting methods, International Journal of Forest Engineering, 10.1080/14942119.2023.2192774
- Blattert, C., Monkkonen, M., Burgas, D., Di Fulvio, F., Caicoya, A.T., Vergarechea, M., Klein, J., Hartikainen, M., Anton-Fernandez, C., Astrup, R., Emmerich, M., Forsell, N., Lukkarinen, J., Lundström, J., Pitzen, S., Poschenrieder, W., Primmer, E., Snäll, T., and Eyvindson, K. (2023) Climate targets in European timber-producing countries conflict with goals on forest ecosystem services and biodiversity, 10.1038/s43247-023-00771-z
- Eggers, J., Roos, U., Lind, T., and Sandström, P. (2023) Adapted forest management to improve the potential for reindeer husbandry in Northern Sweden, AMBIO: A Journal of the Human Environment, 10.1007/s13280-023-01903-7
- Felton, A., Belyazid, S., Eggers, J., Nordström, E-M., and Öhman, K. (2023) Climate change adaptation and mitigation strategies for production forests: Trade-offs, synergies, and uncertainties in biodiversity and ecosystem services delivery in Northern Europe, Ambio, 10.1007/s13280-023-01903-7
- Hallberg-Sramek, I., Nordström, E-M., Priebe, J., Reimerson, E., Marald, E., and Nordin, A. (2023) Combining scientific and local knowledge improves evaluating future scenarios of forest ecosystem services, Ecosystem Services, 10.1016/j.ecoser.2023.101512
- Juvany, L., Hedwall, P-O, Felton, A., Öhman, K., Wallgren, M., Kalen, C., Jarnemo, A., Johansen, H., and Felton, A. (2023) From simple metrics to cervid forage: Improving predictions of ericaceous shrub biomass, Forest Ecology and Management, 10.1016/j.foreco.2023.121120
- Lämås, T., Sängstuvall, L., Öhman, K., Lundström, J., Årevall, J., Holmström, H., Nilsson, L., Nordström, E-M., Wikberg, P-E., Wikström, P., and Eggers, J. (2023) The multi-faceted Swedish Heureka forest decision support system: context, functionality, design, and 10 years experiences of its use, Frontiers in forests and global change, 10.3389/ffgc.2023.1163105
- Llorente de Pellegrin, I., Eyvindson, K., Mazziotta, A., Lämås, T., Eggers, J., and Öhman, K. (2023) Perceptions of uncertainty in forest planning: contrasting forest professionals? perspectives with the latest research, Canadian Journal of Forest Research, 10.1139/cjfr-2022-0193
- Löfroth, T., Merinero, S., Johansson, J., Nordström, E-M., Sahlström, E., Sjögren, J., and Ranius, T. (2023) Land-sparing benefits biodiversity while land-sharing benefits ecosystem services": Stakeholders' perspectives on biodiversity conservation strategies in boreal forests, Ambio, 10.1007/s13280-023-01926-0
- Nordkvist, M., Eggers, J., López-Andújar Fustel, T., and Klapwijk, M. (2023) Development and implementation of a spruce bark beetle susceptibility index: A framework to compare bark beetle susceptibility on stand level, Trees, Forests and People, 10.1016/j.tfp.2022.100364
- Schulte, M., Jonsson, R., Eggers, J., Hammar, T., Stendahl, J., and Hansson, P-A. (2023) Demand-driven climate change mitigation and trade-offs from wood product substitution: The case of Swedish multi-family housing construction, Journal of Cleaner Production, 10.1016/j.jclepro.2023.138487

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., and Ekström, M. (2023). Tests of stochastic dominance with repeated measurements data. AStA Advances in Statistical Analysis, 10.1007/s10182-022-00446-8
- Esseen, P-A., and Ekström, M. (2023) Influence of canopy structure and light on the three-dimensional distribution of the iconic lichen Usnea longissimi, Forest Ecology and Management, 10.1016/j.foreco.2022.120667
- Heiðarsson, L., Nyström, K., and Snorrason, A. (2023) Stem volume and above ground biomass models for Sitka spruce (Picea sitchensis (Bong.) Carr.) in Iceland, Icelandic Agricultural Sciences, 10.16886/IAS.2023.06

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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

- Ersson, B.T., Hansson, L., Manner, J., Sandström, P., and Sonesson, J. (2023) Forest management in northern Fennoscandia: the need for solutions that mitigate conflicts during forest regeneration and increase the use of continuous cover forestry, Silva Fennica, 10.14214/sf.23053
- Haeler, E., ...Lidestav, G., ... and Schueler, S. (2023) Forest subsidy distribution in five European countries, Forest Policy and Economics, 10.1016/j.forpol.2022.102882
- Horstkotte, T.; Sandström, P.; Neumann, W.; Skarin, A.; Adler, S.; Roos, U., and; Sjögren, J. (2023) Semi-domesticated reindeer avoid winter habitats with exotic tree species Pinus contorta, Forest Ecology and Management, 10.1016/j.foreco.2023.121062
- Johansson, K., Johansson, M., ad Andersson, E. (2023) All talk and no action? Making change and negotiating gender equality in Swedish forestry, Forest Policy and Economics, 10.1016/j.forpol.2023.103013
- Lidestav, G., and Westin, K. (2023) The Impact of Swedish Forest Owners' Values and Objectives on Management Practices and Forest Policy Accomplishment, Small-Scale Forestry, 10.1007/s11842-022-09538-4
- Matilainen, A., Andersson, E., Laehdesmaeki, M., Lidestav, G., and Kurki, S. (2023) Services for What and for Whom? A Literature Review of Private Forest Owners' Decision-Making in Relation to Forest-Based Services, Small-Scale Forestry, 10.1007/s11842-023-09541-3
- Niebuhr, B.B., Van Moorter, B., Stien, A., Tveraa, T., Strand, O., Langeland, K., Sandström, P., Alam, M., Skarin, A., and Panzacchi, M. (2023) Estimating the cumulative impact and zone of influence of anthropogenic features on biodiversity, Methods in Ecology and Evolution, 10.1111/2041-210X.14133
- Westin, K., Bolte, A., Haeler, E., Haltia, E., Jandl, R., Juutinen, A., Kuhlmey, K., Lidestav, G., Makipaa, R., Rosenkranz, L., Triplat, M., Skudnik, M., Vilhar, U., and Schueler, S., (2023) Forest values and application of different management activities among small-scale forest owners in five EU countries, Forest Policy and Economics, 10.1016/j.forpol.2022.102881

Book Chapters

- Allard, A., Guerrero, S., Aagaard Christensen, A., Benzler, A., Appelberg, M., Ståhl, G., and Sandewall, M. (2023) Demands on monitoring, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-3
- Allard, A., Wood, C., Norton, L., Aagard Christensen, A., Van Eetvelde, V., Brown, A., Persson, H., and Eriksson, L. (2023) Monitoring as a field, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-2
- Allard, A., Aagaard Christensen, A., Brown, A., and Van Eetvelde, V. (2023) Managing hybrid methods for integration and combination of data, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-9
- Allard, A., Brown, A., Hurford, C., Isendahl, C., Hilpold, A., Tappeiner, U., Strobl, J., and Hedenås, H. (2023) Data collected in situ: unique details or integrated components of monitoring schemes, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-5
- Allard, A., Webber, L., Hentati Sundberg, J., and Brown, A. (2023) New and changing use of technologies in monitoring: drones, artificial intelligence, and environmental DNA, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-8
- Brown, A., Hedenås, H., Holm, E., Lind, T., Richards, A.E., Prober, S.M., and Schmidt, B. (2023) Designing and adapting biodiversity monitoring schemes, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-15
- Keskitalo, C., Allard, A., and Brown, A. (2023) Monitoring biodiversity: - combining environmental and social data, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-1
- Keskitalo, C., and Andersson, E. (2023) Interviews with landowners/managers – what can they provide?, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-14
- Keskitalo, C., Brown, A., and Allard, A. (2023) Reflections on monitoring: conclusions and ways forward, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-18
- Keskitalo, C. and Lidestav, G. (2023) Understanding the social context of monitoring, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-11
- Ranlund, A., Grafström, A., Brown, A., Hedenås, H., and Levin, G. (2023) Designing monitoring systems, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-4
- Sandström, P., Sandström, S., Roos, U., and Cronvall, E. (2023) Case study: reindeer husbandry plans – "Is this even monitoring?", In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-17
- Wood, C., Sandewall, M., Sandström, S., Ståhl, G., Allard, A., Eriksson, A., Isendahl, C., Norton, L. (2023) Social data: what exists in reporting schemes for different land systems?, In: Monitoring biodiversity: - combining environmental and social data, 10.4324/9781003179245-10

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.

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

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National Inventories of Landscapes in Sweden

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). The inventory started in 2020.

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. The inventory started in 2020.

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). The inventory started in 2021.

NILS Wetland inventory

NILS was tasked with designing a pilot study on wetlands, specifically focusing on raised bogs. In 2023, a national inventory of raised bogs was conducted, with particular attention given to those with high nature values as 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. The inventory started in 2006 with a break during the years 2021 and 2022.

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.

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

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Forest Sustainability Analysis

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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