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Demonstration of Methods to monitor Sustainable Forestry

Final report Sweden

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Demonstration of methods to monitor sustainable forestry
EU/LIFE project 1998 – 2001 (LIFE98ENV/S/000478)

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Final report Sweden

Karl Gustafsson

About the project:
The project is designed to review, demonstrate and develop methods to monitor sustainable forestry as defined by the pan-European process. It is supported by the EU-LIFE fund. Totally 7 organisations from Denmark, Finland, France, Germany and Sweden are participating. Lead agency is the National Board of Forestry in Sweden.

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Preface

In July 1998 the European Commission approved the LIFE project "Demonstration of Methods to Monitor Sustainable Forestry". The project is a joint effort by the proposer, The National Board of Forestry, Sweden and the partners:

- The Danish Forest and Landscape Research Institute, Denmark
- The Forestry Development Centre TAPIO, Finland
- The Institut pour le Développement Forestier, France
- CEMAGREF, France
- Niedersächsische Forstliche Versuchsanstalt, Germany
- The Swedish Environmental Protection Agency

The partners have also co-operated with other national organisations within their countries.

The demonstration of methods has been carried out in the 12 demonstration areas located throughout the partner countries as indicated on the front page. In Sweden, 2 demonstration areas were chosen in Vällen, Uppland and Skröven, Norrbotten. The Swedish Environmental Protection Agency co-ordinated the work in Vällen whilst the Skröven area has been managed by the Regional Forestry Board of Norrbotten.

This is the final report from the joint Swedish component of the project in which overall results and conclusions are presented. Results from the demonstration of methods are described in detail in several technical reports from each demonstration area.

National Board of Forestry

Swedish Environmental Protection Agency

Summary

In the LIFE-project "Demonstrations of Methods to Monitor Sustainable Forestry" seven partners from five countries have joined efforts to demonstrate and develop monitoring methods. In Sweden the National Board of Forestry (NBF) and the Swedish Environmental Protection Agency (SEPA) has co-operated within two selected demonstration areas in Uppland and Norrbotten.

In the initial phase of the project each participating country carried out a thorough analysis of their respective monitoring systems. The output from current monitoring activities was matched against the quantitative indicators for sustainable forestry adopted by the Ministerial Conference on the Protection of Forest in Europe (MCPFE). This so-called Gap-analysis resulted in a visualisation of to what extent current monitoring can provide data on the indicators. The analysis also included assessment of which existing indicators are relevant in Sweden and in which fields indicators are missing. The project team suggested new indicators where gaps were identified.

The lack of good indicators for Swedish conditions was pinpointed in the fields of *biological diversity*, *non-wood forest products*, *protective functions* and *socio-economic functions and conditions*. A large number of new indicators are suggested. The gap in Swedish monitoring coincides to a large extent with the lack of good indicators. Existing indicators in the fields of *forest resources*, *forest health & vitality* and *production function*s are generally considered valid. Current monitoring activities covers most of these indicators. For a complete follow-up, it was concluded that additional indicators are needed also under these criterions.

A number of monitoring activities was carried out in each demonstration area. In Vällen, the demonstration task focused on assessing variables of interest for *biological diversity*, *protective functions* and *production functions* while demonstration in Skröven focused on *socio-economic functions*, *production functions* and *forest resources*. Some methods demonstrated are new whilst other are existing methods used in a new area or in a new way.

Methods tested and demonstrated include assessing volumes of dead wood, populations of three-toed woodpecker, forest buffer zones to shorelines, populations of woodliving insects, forest resource variables through remote sensing, effect on reindeer lichen forage by final fellings etc. Some of the methods are ready for large-scale use e.g. inventory of buffer zones to shorelines while other may need adjustments depending on local conditions or the size of the area to survey.

The project presents all demonstration efforts in 9 technical reports that can be obtained on the Internet (www.svo.se/life) or from NBF and SEPA.

1. Introduction

This report aims to describe the work, results and conclusions of the Swedish component of the EU/LIFE co-funded project "Demonstration of Methods to Monitor Sustainable Forestry". In addition, the Swedish component has produced a number of technical reports describing in detail the different activities of the project.

The project "Demonstration of Methods to Monitor Sustainable Forestry" started in June 1998 on the initiative of the National Board of Forestry. In all, the project has 7 partners from 5 European countries (Sweden, Denmark, Finland, Germany and France).

The main objective of the project has been to demonstrate methods to monitor aspects of sustainable forestry. This work has included not only the actual demonstration and testing of methods but also assessing the relevance in Sweden of the Criteria & and Indicators for sustainable forestry (Anon. 1998) adopted by the Ministerial Conference for the Protection of Forest in Europe (MCPFE).

The MCPFE indicators were judged by their relevance under Swedish conditions. At the same time the reliability of existing monitoring methods covering these indicators were assessed. This so-called Gap-analysis (Sollander 2001) contributed to further work as it identified indicators of sustainability not covered by existing methods or where the reliability of existing methods are low. The work also included pointing out areas of relevance for sustainability not covered by the MCPFE indicators and suggesting new indicators.

The choice of methods to be tested and demonstrated originated from the project application to the LIFE fund and the findings in the Gap-analysis. Two demonstration areas were selected in different parts of Sweden to cover different forest conditions. In Uppland, an area of approx. 15 000 ha around lake Vällen were chosen. In Norrbotten the choice fell upon a larger area around the small village of Skröven.

The outline of this report roughly follows the chronological order in which tasks have been undertaken in the project. Chapter 2 describes the Gap-analysis. In chapter 3, major existing monitoring methods in Sweden are described and the existing and suggested indicators are listed in connection with the appropriate monitoring method. In chapter 4, all inventory/monitoring activities carried out in the project are described. Results and conclusions from the project are discussed in chapter 5. Dissemination activities and known media attention are described in chapter 6.

2. Gap-analysis

A major undertaking in the beginning of the project was the GAP-analysis. The name (Gap-analysis) indicates the overall objective to analyse the gap between a "desired" state of monitoring system and the actual state. The basis for the Gap-analysis was the scheme of Criteria & Indicators (C & I) for sustainable forest management adopted by the Ministerial Conference on the Protection of Forests in Europe (MCPFE) (Anon. 1998). The Gap-analysis objective can be divided into two major areas (Sandström 1999):

1. Identify which indicators are suited to judge sustainability of forests benefits at national and demonstration area level.
2. Identify needs to develop new monitoring methods or to improve existing methods in a country or in an area.

Within the project, the result of the Gap-analysis has come to use in planning the efforts of demonstrating monitoring methods within the demonstration areas.

2.1. Methods and results

2.1.1. Methods

The Gap-analysis exercise was conducted as a questionnaire. In the questionnaire (see Sollander 2001), the project teams of the participating countries were asked to mark each of the MCPFE quantitative indicators based on their validity for the criteria and concept area concerned and also the reliability of existing monitoring methods incident to them. When filling in the Gap-analysis questionnaire, a possibility of suggesting new concept areas and indicators to improve the system was given.

The national Swedish project manager answered the national Gap-analysis questionnaire with assistance from experts from the National Board of Forestry and the Swedish Environmental Protection Agency. The project steering group decided upon the reply. For guidance in completing the questionnaire, PM presented a draft guide (Sandström 1999). The local project staff in each demonstration area answered the Gap-analysis questionnaires concerning the two areas.

The question of missing elements in the C & I scheme was addressed in a brainstorming session resulting in over 50 new possible indicators. Some of these are possibly not useful outside of Sweden. No prioritising of the suggested indicators was done in the project. The list would serve as a base for further discussion and evaluation.

The full context of the Swedish answer to the questionnaire is published in the project Gap-analysis report (Sollander 2001). An overview of the C & I monitoring scheme and Swedish monitoring methods are given in chapter 3

2.1.2. About the interpretation of Gap-analysis results

Some problems when filling in the questionnaire need to be commented for the understanding of the results.

For all criteria and concept areas their relative importances were marked using four classes ranging from *not important* to *very important*. For the MCPFE quantitative indicators the validity have been marked as well as the reliability of existing monitoring methods (if existing). The marking was done to four classes ranging from *not valid/reliable* to *very valid/reliable*. Suggested new indicators were marked on their relative importance to the concept area and the reliability of existing monitoring methods. The assessment was done on different geographical scales (national and demonstration areas). As the markings were made quite subjectively this arises the question what "validity" stands for. In the draft instruction for filling in the questionnaire, validity is defined as how well the indicator reflects the object of interest (the object of interest being the elements above in the C & I hierarchical structure). In the example of validity of Ind. 1.3 *Total carbon storage and changes in carbon storage in forest stands* the answer was *valid* in the national questionnaire while it was considered of lower validity on the demonstration area level. Considering the Kyoto protocol (Anon 1999) it is easy to understand the marking on a national level as the commitment to reduce CO_2 emissions are specified for the whole nation. For the demonstration areas this indicator was considered of lesser importance as no commitments are made on this level. For sustainability one could argue the same validity on all geographical scales. The marking does however reflect a subjectively judged level of how interesting or useful the figures are. Readers will have to keep geographical differences in mind when interpreting results from the questionnaire. Unfortunately, the motives for differences in the marking where never described.

The MCPFE quantitative indicators are vaguely defined and some allow several interpretations. To describe their validity and the reliability of existing monitoring methods we needed to decide how to interpret the indicator. In some cases this meant creating more precise definitions. This has been done and the marks on validity and reliability need to be interpreted with theses suggested interpretations/definitions in mind. A table of suggested definitions for all existing and some suggested indicators are presented in chapter 3. All suggested indicators and definitions are presented in the Gap-analysis report (Sollander 2001).

2.1.3. Results

The Gap-analysis yielded large amounts of results, which to some extent have come to use already within the project. In the following, some comments are made concerning the results of the Swedish answer to the questionnaire. As the suggested indicators are numerous and in most cases not fully developed it has not been possible to present all of them in the following comments. The (subjectively chosen) most important or interesting are mentioned.

2.1.3.1. Criterion 1. Forest resources

Under Criterion 1 (Forest resources) existing MCPFE indicators are generally marked as valid for the concept areas. In most cases, reliability of the existing monitoring methods is high, at least on the national level. Existing monitoring

method in this case is often the National Forest Inventory (NFI). Several new indicators are suggested, e.g. concerning the quality of regenerations, wood quality, use of wood based fuels, etc. (see Sollander 2001).

2.1.3.2. Criterion 2. Health and vitality

Under Criterion 2 (Health and vitality) indicator validity ranges from 1-4 in the national reply. Some of the forest health risks are not present or important in Sweden. For the Criterion, currently without concept areas, two concept areas are suggested, 1) *Nutrient and acid/base-budget*, 2) *Damages and risks*. Under the suggested concept area 1, indicators dealing with forest area with decreasing saturation of CEC and ratio of carbon to nitrogen are suggested. Under the suggested concept area 2, a number of new indicators are suggested including indicators dealing with forced fellings, total mortality and capitalised loss of value/volume, mechanical damage in thinning operations, etc. (see Sollander 2001). Existing and suggested indicators are/can be monitored in the NFI, Swedish Survey of Forest Soils and Vegetation (SSFSV) or through monitoring within the ICP-programme and Polytax.

2.1.3.3. Criterion 3. Productive functions of the forest

Under Criterion 3 (Productive functions of forests) the marking of existing indicators are generally low even though the concept area under which they are placed were considered important. For example Ind. 3.2 *Percentage of forest area managed according to management plan or management guidelines* has not been possible to define into anything meaningful for sustainability in Sweden.

New indicators are suggested including indicators dealing with; future quality of wood, size and value of annual harvest, annual area of cleaning and thinning, quality of regenerations, area of burned forest etc. (see Sollander 2001). Under concept area *Non-wood products* new indicators are suggested dealing with fishing and nature-tourism. Most suggested indicators can be or are already being assessed in the NFI or through NBF annual questionnaires.

2.1.3.4. Criterion 4. Biological diversity

Concept areas under Criterion 4 (Biological diversity) are generally considered important or very important in the national response. A number of indicators are suggested for this new concept area. In addition a new concept area is suggested dealing with representative not threatened species, their genetic variation and response to fragmentation.

The existing indicators under this criterion are judged very different with respect to their validity for the concept areas. Also the reliability of existing monitoring methods vary a lot. The complexity of describing biological diversity as well as the ecological differences between areas throughout Europe may be a reason for validity problems when formulating all-European indicators. A large number of new indicators are suggested including ones concerning forest ecosystem with biological values created by cultural influence, area affected by disturbances, dead wood, giant trees, voluntarily protected forest areas, treatment of biological values in final cutting, genetic variation, fragmentation etc (see Sollander 2001). Some of

the suggested indicators have yet to be properly defined. Most of the existing and suggested indicators are at least to some extent already monitored in Sweden, either through the NFI-, Polytax- or biodiversity in key habitat inventories or are collected and recorded in databases at the NBF, Swedish Environmental Protection Agency (SEPA), Swedish Threatened Species Unit (STSU) or local authorities.

2.1.3.5. Criterion 5. Protective functions

The concept area *General protection* and *Water conservation* in forests under Criterion 5 (Protective functions) are judged to be very important for Swedish conditions. The concept area *Soil erosion* was however considered of little importance. Existing MCPFE indicators under these criteria are currently not monitored in Sweden and none of the indicators were given the highest mark on validity. Instead a number of new indicators are suggested including; area of forest available for wood supply with a protection function according to §15 in the Swedish Forestry Act, area of protective ditching, proportions of buffer zones to shores of water affected by forestry, number of watercourses negatively effected by forest management etc. (see Sollander 2001). Two new concept areas are suggested; *Protective functions against wind, snow and temperature* and *Protective functions for the soil*. Under these concept areas, indicators are suggested covering the following aspects; share of deciduous trees in conifer stands for storm protection, proportion of regeneration area with shelterwood for protection against frost and area that has been treated with lime.

2.1.3.6. Criterion 6. Other socio-economic functions and conditions

Criterion 6 (Other socio-economic functions and conditions) are organised into 7 concept areas under which MCPFE only presents 3 quantitative indicators. These deal with the economic significance of the forest sector in a national perspective, provision of recreation and employment rate in forestry. The indicators are all marked valid or very valid and the existing monitoring methods (National statistics) are considered reliable or very reliable. The shortage of MCPFE indicators are compensated by a large number of suggested new indicators in the Swedish answer to the questionnaire.

Under concept area *Significance of the forest sector*, indicators are suggested concerning; forest sector proportion of national exports of goods and services and area of country where forest sector economy exceeds 10% of total regional economy. Under concept area *Recreational services,* indicators are suggested concerning proportion of forest area easily accessible to man, share of roads with common access, length of hiking tracks etc. (see Sollander 2001). Concept area *Provision of employment* has been supplemented with indicators dealing with; work hours performed by forest owners themselves, employment in Eco-tourism and employment in reindeer husbandry. Under concept area *Research and professional education* suggestions of new indicators include monitoring of changes in: number of persons in forestry education programmes, share of forest sector turnover used for R & D and number of Ph.D. examinations. Concept area *Public participation* has been supplemented with indicators concerning working hours spent by NGO's on forestry, amount of extension services provided by the

Regional Forestry Boards (RFB) and number of "school forests" established in the project "Forestry in school". Under concept area *Cultural values* indicators are suggested dealing with preservation of cultural sites and landscapes.

2.2. General conclusions

The Gap-analysis task was to judge existing indicators, assess how well they are currently monitored in Sweden and to suggest new indicators in areas where aspects of the criteria wasn't considered to be covered.

The gap between a desired state of monitoring system and the current can be derived by studying existing and suggested indicators marked with high validity and low reliability. In the Swedish case it is obvious that many of the indicators dealing with forest resources and wood production are well covered by the NFI and other existing forest/forestry monitoring system. Also, forest health and vitality are currently monitored to a large extent, although often with lower reliability. Major gaps are instead found in the monitoring of biological diversity, non-wood forest products and socio-economic functions and conditions.

It should be noted that markings as well as the formulation of new indicators have been made subjectively.

Experiences from the Gap-analysis were valuable input when deciding which inventories and inquiries to conduct. In the Vällen demonstration area, work focused on monitoring biological diversity whilst work in the Skröven area focused on variables dealing with non-wood goods and multiple use of forestland.

As the results from the Gap-analysis have already come to use within the project, the question if it can be used further is arisen. The reliability (or lack of reliability) of existing monitoring methods were already well known but can to some extent be visualised to the reader and put in larger context. The obvious continuation of the Gap-analysis would be to adapt the MCPFE indicators to Swedish conditions. A major conclusion would be the difficulties ahead to put together a cost-efficient monitoring scheme comprehensive enough to cover all interesting (or at least most) aspects of sustainability and yet contain a workable set of indicators –and then reach consensus on it among the forest sector players involved. The marking of MCPFE indicators arose some differences in opinion within the project when the questionnaire was completed. The obvious reason for this was the subjectivity involved. In most cases however the markings were easy to agree upon. A large number of new indicators were suggested but little effort was put on sorting out the most important new indicators. A weakness of the C & I for national use is that it does not point out any target values or, in many cases, no desired direction of changes of indicator values. This fact and the fact that national target and objective setting hasn't been based on MCPFE indicators have led to that little attention have been paid to the C & I system.

3. Monitoring of quantitative indicators in Sweden

This chapter aims to provide the reader with an overview of monitoring of quantitative indicators in Sweden. In chapter 3.1 some of the most important inventories and inquiries referred to are described. Existing and some of the suggested indicators are listed in chapters 3.2 - 3.7 and current national level monitoring methods/systems (if existing) are pointed out. The indicators are presented with numbers given in the MCPFE L2 resolution (Anon 1998). An abbreviation of their original heading are used and if needed complemented with suggested clarifications to fit Swedish conditions.

3.1. Major monitoring systems in Sweden.

3.1.1. National Forest Inventory

The National Forest Inventory (NFI) is the most important source of objective information on the forests of Sweden. NFI is a sample plot inventory, which covers the entire country each year. It is therefore possible to produce estimates on forest variables using single year data. In most cases, estimates used and published are based on data from 3-5 years to reduce the sampling error. Growing stock, increment, fellings and variables related to the forest structure and forest damages are some example of output from the NFI.

The sampling includes both permanent and temporary sample plots of which the permanent currently is re-measured every 10th year. Sample plots are clustered in "tracts" -the tracts allocated systematically in a grid -making the inventory work more rational then having a systematic grid of single sample plots.

3.1.2. Swedish Survey of Forest Soils and Vegetation

A supplementary part to the NFI is the Swedish Survey of Forest Soils and Vegetation (SSFSV), which carry out separate measurements on the permanent sample plots. SSFSV gives a general site description of the area closely surrounding the plot, including e.g. general hydrological conditions and soil depth. Soil types/horizons and vegetation with emphasis on non-timber aspects are also described. SSFSV takes samples of organic and mineral soil horizons for subsequent chemical analyses and assess pendulous lichens and algal growth on spruce needles.

3.1.3. Polytax

The final felling and the subsequent regeneration work are the forest management operations that have the strongest impact on both environmental values and future wood production. Thus it is natural that monitoring of these operations is an essential element in the Swedish follow-up system. This is done by the Swedish Forestry Administration through the monitoring system Polytax.

The main objectives of Polytax are monitoring of environmental considerations in connection with final felling and of regeneration quality against the standards set in the Forestry Act. R-Polytax is producing detailed results for the whole country and for large regions. D-Polytax is producing less detailed results for forestry districts. Both are based on sampling of compartments notified for final felling.

In R-Polytax, field inventory is carried out on three different occasions. The first (R0) is made just before final felling in order to survey the environmental values possible to consider in the harvesting operation. The second (R1) is made approximately one year after final felling when the actual environmental considerations are surveyed. The third (R5/7) is made five or, in northern Sweden, seven years after final felling. At that occasion the quality of regenerations is assessed through a plot inventory. Furthermore, the amount of wood, dead or alive, left in the harvested compartment is estimated.

In D-Polytax field inventories are only made one year (D1) and five or seven years after final felling (D5/7).

In combination with information from the KOTTEN information system the results from Polytax can be analysed together with demographic data on owners or local intensity in extension services or counselling

3.1.4. Monitoring of forest health & vitality

Two major systems of monitoring forest health & vitality are currently carried out in Sweden. The National Forest Inventory is responsible for measurements of e.g. crown condition at a sample of their permanent sample plots. These measurements are also a part of the pan-European monitoring system (level I plots). The National Board of Forestry is responsible for more intensive monitoring on 223 “observation plots” distributed across the country. A large number of variables are measured dealing with needle/leaf chemistry, tree vitality, climate, growth, soil chemistry, deposition of air pollutants, soil water chemistry etc. Several organisations are involved to take care of measurement and data processing within their respective fields of expertise. 100 of these plots are integrated in the European monitoring programme (level II plots).

3.1.5. Monitoring of biodiversity in Woodland key habitats

Starting from 2000, a sample of woodland key habitats will be repeatedly inventoried regarding changes in their biological values. The assessment will focus on selected indicator species that by their presence indicate high biological qualities of certain habitats. A total of 11 different types of habitats have been selected for the assessment and 67 indicator species have been used in the inventory. These are lichens, mosses, wood inhabiting fungi and vascular plants. There are 491 woodland key habitats in the sample spread all over Sweden. A systematic reassessment of the areas will make it possible to monitor changes in the size of populations and presence of the species over time. Since the selected indicator species can be expected to react to changes in their environment, they might function as an early warning system regarding general loss of biodiversity in the woodland key habitats.

3.1.6. The KOTTEN information system

The National Board of Forestry has developed an information system (comprising a GIS subsystem) which holds information about the forests nation-wide. Currently it holds, except from background information in maps and satellite images, records from the key habitat inventory, inventory of wetlands, notifications of final fellings, and other administrative data. The Regional Forestry Boards conduct updates as changes come to their knowledge. The system is a useful tool for the forest authorities when planning inspection work or identifying target group for information efforts. Notifications to the Forestry Boards of final fellings, protective ditching or use of exotic tree species can be used for continuos monitoring of these activities. The Polytax sample is continuously generated from KOTTEN when notifications of final felling are registered.

3.2. Indicators under Criterion 1. Forest resources

No	Abbreviated name of Pan-European and added quantitative indicators for sustainable forest management in Sweden	Suggested indicator definitions adapted to Swedish conditions	Current monitoring method useful for assessing indicator of interest on national level	Moni proje intere
	Concept area: Land use and forest area			
1.1	Area of forest and other wooded land and changes in area…	See 1.1a-d	-	-
1.1a	Forest area and changes	Total forest and other wooded land area in hectares and percent of total land area. Change per decade.	The National Forest Inventory provides objective information for the nation and for larger regions.	-
1.1b	Ownership structure	Forest area in hectares and percent per class of owners. Changes per 5-10 years periods. Forest and other wooded land (FAWS)	NFI sampling includes owner category. Information available with high quality for the nation and large regions.	-
1.1c	Age-structure	Forest area per age class. Area per age class and dominating tree species. Changes over 5-year periods (FAWS).	NFI.	The k Skröv uses N appoi image variab accur using
1.1d	Vegetation types and changes.	Area per vegetation type (according to Hägglund & Lundmark 1981). Changes over 5-year periods (FAWS).	NFI. Additional information from the permanent sample plots is collected in the Swedish Survey of Forest Soils and Vegetation (SSFSV).	-
	Concept area: Growing stock			

1.2a,b	Changes in total volume of growing stock and mean volume of growing stock.	Changes in total volume (m^3sk/ha) over 5 year periods and changes in mean volume of growing stock (FAWS).	NFI covers forest land according to national definitions and measures a few variables on other land classes. Mountain regions, which fall under the international definition of forest or other wooded land, are not covered.	kNN- estim areas metho availa that i cover
1.2c	Change in age structure and diameter distribution.	No relevant definition suggested.	NFI.	Age s monit struct diffic
	Concept area: Carbon balance			
1.3	Total carbon storage and changes…	Total carbon storage in forest stands and soils and changes over 5-10 year periods (tons/hectares) (FAWS).	NFI (total biomass), SSFSV (carbon content of the soil).	-
Add	Carbon content in wood based fuels compared to carbon content in total energy production	Ratio of carbon content in wood based energy to carbon content in all raw materials used for production of energy by combustion.	Energy statistics.	-

3.3. Indicators under Criterion 2. Health and vitality

No	Abbreviated name of Pan-European and added quantitative indicators for sustainable forest management in Sweden	Suggested indicator definitions adapted to Swedish conditions	Current monitoring method useful for assessing indicator of interest on national level	Moni proje intere
Add	Suggested concept area: Nutrient and acid/base budget			
2.1	Total amount of and, changes over the past 5 years in depositions of air pollutants.	Changes over 10 year periods in depositions of nutrients and air pollutants under forest cover, notably H+, S-SO4, Nox, N-NO3, N-NH4, Ntotal, Mg, Ca, K, Al, Cl, Na, Fe, Mn.	On ICP forest level 2, sample plot information is gathered to cover this indicator. Due to the limited number of sample plot and subjective elements in the sample plot distribution, the inquiry has some reliability problems. Results can be seen as indications of changes. Large micro variations make in e.g. pH average values over large areas of limited interest.	-
2.4	Changes in nutrient balance and acidity over the past 10 years (pH and CEC) …..	Changes over 5-10 year periods in nutrient balance, cation exchanges capacity, base saturation percentage. (meq/100 g soil, pH, % CEC-saturation).	ICP forest level 2. Some variables are collected in the Swedish Survey of Forest Soils and vegetation (SSFSV).	-
Add	Change in saturation of CEC	Proportion of forests (FAWS) with decreasing saturation of CEC.	SSFSV as above.	-
Add	Ratio between nutrients.	Ratio of carbon to nitrogen(C/N) in forests available for wood supply (FAWS)	SSFSV as above.	-
Add	Suggested concept area: Damage assessment			
2.2	Changes in serious defoliation of forests using UN/ECE and EU defoliation classification over the past 5 years.	Changes over 5 year periods of leaf cast (for main tree species) using UN/ECE classes 2- 4 (FAWS).	ICP-Forest Level 1.	-

2.3a	Serious damage caused by biotic or abiotic agents… insects and diseases.	Killed trees and volume per disease/damaging agent. Area affected (FAWS).	ICP forest level 1 and the NFI gives information on tree vitality, damages to stands and trees and to some extent damaging agent.	-
2.3b	Serious damage caused by biotic or abiotic agents… fire.	Area/volume of burned forest and changes (FAWS).	Statistics Swedish Rescue Service.	-
2.3c	Serious damage caused by biotic or abiotic agents… storm.	Area/volume of windthrown forest and changes (FAWS).	NFI provides data on trees damaged by wind on regional and national level. Accuracy is low. NBF carries out ad hoc studies (often inquiries) when large-scale windthrows occur.	-
2.3d	Serious damage caused by biotic or abiotic agents…grazing.	Area of serious damage to regenerations caused by grazing (fresh & accumulated).	NFI, Polytax, ÄBIN. NFI gives national data on damages to young stands. Polytax provides data on grazing damages to regenerations. In ÄBIN annual grazing pressure in young stands are measured on a local level.	-
Add.	Total mortality.	Total mortality and changes as percent of gross annual increment (FAWS).	NFI.	-

3.4. Indicators under Criterion 3. Productive functions of the forest

No	Abbreviated name of Pan-European and added quantitative indicators for sustainable forest management in Sweden	Suggested indicator definitions adapted to Swedish conditions	Current monitoring method useful for assessing indicator of interest on national level	Moni proje intere
	Concept area: Wood production			
3.1	Balance between growth and removal..	Balance between annual growth and total drain. Changes in balance, forest available for wood supply (FAWS).	NFI as above.	-
3.2	Percentage of forest area managed according to management plan…	Not considered relevant to Swedish conditions.	-	-
Add.	Economic value of wood production	Annual value of timber removed from forests and other wooded land.	NBF Statistics	-
Add.	Silviculture	Annual area of cleaning and thinning. Changes in annual area (FAWS)	NFI and NBF questionnaires. NBF caries out 2 separate inquiries to small- and large-scale forestry concerning silvicultural activities.	-
Add.	Quality of regenerations	Area with satisfactory regeneration according to Forestry act (FAWS)-	Polytax.	-
	Concept area: Non-wood products			
3.3	Total amount of and changes in the value and/or production of non-wood forest prod.	Quantity and value of non-wood products brought to the market	NFI, Swedish hunters association. National board of agriculture.	Total estim produ marke

3.5. Indicators under Criterion 4. Biological diversity

No	Abbreviated name of Pan-European and added quantitative indicators for sustainable forest management in Sweden	Suggested indicator definitions adapted to Swedish conditions	Current monitoring method useful for assessing indicator of interest on national level	Moni proje intere
	Concept area: Representative, rare and vulnerable forest ecosystems			
4.1a	Changes in the area of natural and seminatural forest types.	Area and changes of natural and ancient seminatural forest types.	NFI provides information on area of forest with "characteristics" of natural forests. Registers at local county boards (CB) provide (incomplete) information on natural forest.	-
4.1b	Changes in the area of strictly protected forest reserves.	Area and changes of areas under different national protection types.	Records at the CB, Regional Forestry Boards (RFC) and at the Swedish Environmental Protection Agency (SEPA).	-
4.1c	Changes in the area of forest protected by special management regime.	No relevant definition is suggested.	Records at CB and RFB.	-
Add	Forest with ecological values created by cultural influence	Forest area affected by grazing by domestic animal	Records at CB.	-
	Concept area: Threatened Species			
4.2	Changes in the number and perc. of threatened species in relation to total number of species	Ratio of red listed species to the total number of species in the forest.	Records at Swedish Threatened Species Unit.	Inven wood local be co data a habita substr specie
	Concept area: Biological diversity in production forests			

4.3	Changes in the proportions of stands managed for the conservation and utilisation of forest genetic resources…	No relevant definition is suggested.	-	-
4.4	Changes in the proportion of mixed stands of 2-3 species.	Percent of area with 3 or more species. Coniferous/ deciduous trees should represent at least 20/10 % of the basal area respectively (FAWS).	NFI.	-
4.5	In relation to total area of regeneration, proportions of annual area of natural regeneration.	Annual area of natural regeneration as share of total regeneration area. (FAWS).	NFI, Polytax.	-
Add.	Treatment of biological values in final felling.	Percent of total area of regeneration fellings with satisfactory environmental considerations according to Forestry Act.	Polytax gives information on environmental considerations in regeneration fellings compared to the standards set in the Forestry Act (§30).	-
Add.	Giant trees	Changes in the number of giant trees (bigger than a selected diameter per species, often 1 m)	NFI	-
Add.	Dead wood	Changes in amount of dead wood per hectare (FAWS)	NFI	Inventory of de produce estima with NFI data. easily be altere
Add.	Voluntarily set-aside areas	Area and changes of voluntarily set-aside areas.(FAWS)	NBF questionnaires.	
Add	Suggested concept area: Stand structure			

3.6. Indicators under Criterion 5. Protective functions

No	Abbreviated name of Pan-European and added quantitative indicators for sustainable forest management in Sweden	Suggested indicator definitions adapted to Swedish conditions	Current monitoring method useful for assessing indicator of interest on national level
Add	Concept area: Erosion		
5.1	Proportion of area managed primarily for soil protection.	No relevant definition for sustainability is suggested.	Records at NBF
Add	Protection forests.	Area and changes of forest with a protection function (§15 Forestry Act).	NFI, RFB records.
	Water conservation in forests:		
5.2	Proportion of forest area managed primarily for water protection.	No relevant definition for sustainability is suggested.	-
Add	Ditching.	A) Proportion of final felling with report of protective ditching B) Forest area with ditch cleaning	NFI, Notifications of final fellings (RFB)
Add	Bufferstrips to shores of water.	Ratio of length of bufferstrips to shores of seas, lakes, streams etc. to total lengths of shores affected by forest management (notably final felling) (FAWS).	-
Add.	Concept area Protective functions against wind, snow and temperature		
Add.	Protection against wind.	Proportion of deciduous trees in coniferous stands (FAWS).	NFI.
Add.	Protections against frost.	Proportion of regeneration area with shelterwood (FAWS).	RFB notifications of final felling, Polytax.
Add.	Concept area: Protective functions for the soil		
Add	Liming	Area that has been limed and/or vitalised. Annual area of liming/vitalisation.	RFB/CB records.

3.7. Indicators under Criterion 6. Other socio-economic functions and conditio

No	Abbreviated name of Pan-European and added quantitative indicators for sustainable forest management in Sweden	Suggested indicator definitions adapted to Swedish conditions	Current monitoring method useful for assessing indicator of interest on national level
	Concept area: Significance of the forest sector		
6.1	Share of the forest sector from the gross national product.	Share of the forest sector from the gross domestic product and changes.	National (industrial, economic) statistics.
Add.	Foreign trade.	Value of exports from forest sector as share of total national exports and changes.	National (industrial, economic) statistics.
Add.	Forest sector in regional economy.	Proportion of the country where forest sector economy exceeds 10% of total regional economy.	National, regional (industrial, economic) statistics.
	Concept area: Recreational services		
6.2	Provision of recreation: area of forest with access per inhabitant, % of total forest area.	-	Regulated through the tradition of "right of common access". i.e. all forest land.
	Concept area: Provision of employment		
6.3	Changes in the rate of employment in forestry, notably in rural areas (…forestry, logging, forest industry).	Total number of employees in forestry and industry and compared to employment in all sectors.	National employment statistics.
Add	Use of labour.	Labour input per harvested m³.	Statistics, NBF Survey.
	Concept area: Research and professional education		
Add.	Forestry education.	Number of students in forestry programmes (per programme) and changes.	Programme facilitators.
	Concept area: Pubic awareness		
	Concept area: Public participation		
	Concept area: Cultural value		

4. Monitoring methods demonstrated within the project

4.1. The demonstration areas

The demonstration of methods in Sweden was carried out in two separate demonstration areas. The areas were selected to represent boreal and northern boreal forest. In the latter case, it was also declared desirable to choose an area within which reindeer herding occur. The choices fell upon an area surrounding lake Vällen in Uppland and a rather large area around the village of Skröven in Norrbotten.

4.1.1. Vällen

The Vällen demonstration area is situated in north-eastern Uppland. The total area amounts to 15 100 hectares of which 13 000 is productive forest land according to national definitions. Over 1 100 hectares are water.

The forest is dominated by coniferous species. Scots pine (Pinus Sylvestris) constitutes 38 % of the growing stock while 48 % is Norway spruce (Picea Abies). The remaining 14 % are broad-leaved species. Average site class is 7.0 m^3sk/ha,year which is well above the national average of 5,3 m^3sk/ha,year. The age class distribution is rather even and the area holds a large share of mature forests. Companies own almost 90 % of the area. There are several nature reserves within the area.

Figure 4.1-1. The demonstration areas

4.1.2. Skröven

The Skröven demonstration area is situated in central Norrbotten. The total area is almost 280 000 hectares of which 162 000 hectares are productive forest land (outside nature reserves).

The forests are dominated by coniferous species. Scots Pine constitutes 62 % of the growing stock while 22 % is Norway Spruce and 16 % is birch. Less than 1 % are other broad-leaved species and Contorta Pine (Pinus Contorta). Average site class is 3,1 m^3sk/ha,year. Forest companies own 53 % of the productive forest while 31 % is privately owned. The remaining 16 % are commonly-owned. The area encloses two nature reserves with a combined area of 27 000 hectares. A little less than half of this would be classified as productive forest land if it hadn't been nature reserves.

4.2. *k*NN-estimation

The *k*NN-method (*k*NN: the *k* nearest neighbour) is a remote sensing technique combining satellite data and forest inventory plots. The technique makes it possible to produce continuous estimates of forest parameters (e.g. wood volume, age and biomass) over an area. In the Skröven area this method has been used to assess forest variables using SPOT satellite data and sample plot data from the National Forest Inventory (NFI).

Individual raster cells (pixels) in the satellite images are matched and associated with the NFI plots. Relationships between the reflectance in the image and NFI plot data are established. This means that the forest features are known in a number of image pixels.

The goal is to estimate volume, tree species composition, age etc for every pixel in the image using the relationships established between reflectance in the image and NFI sample plot data. The *k*NN method uses an algorithm where the *k* (a variable usually between 5 to 20) most similar reference plots are used to assign forest data values to each pixel in the image.

The method works well to estimate averages of these forest variables over larger areas. On pixel level, the precision is low. Generally the method tends towards the average and therefore often underestimates high values and overestimate low values. Features not well represented in the NFI data area often not correctly represented in the estimations. In Skröven for example, the estimates concerning Contorta (Pinus Contorta) were not reliable.

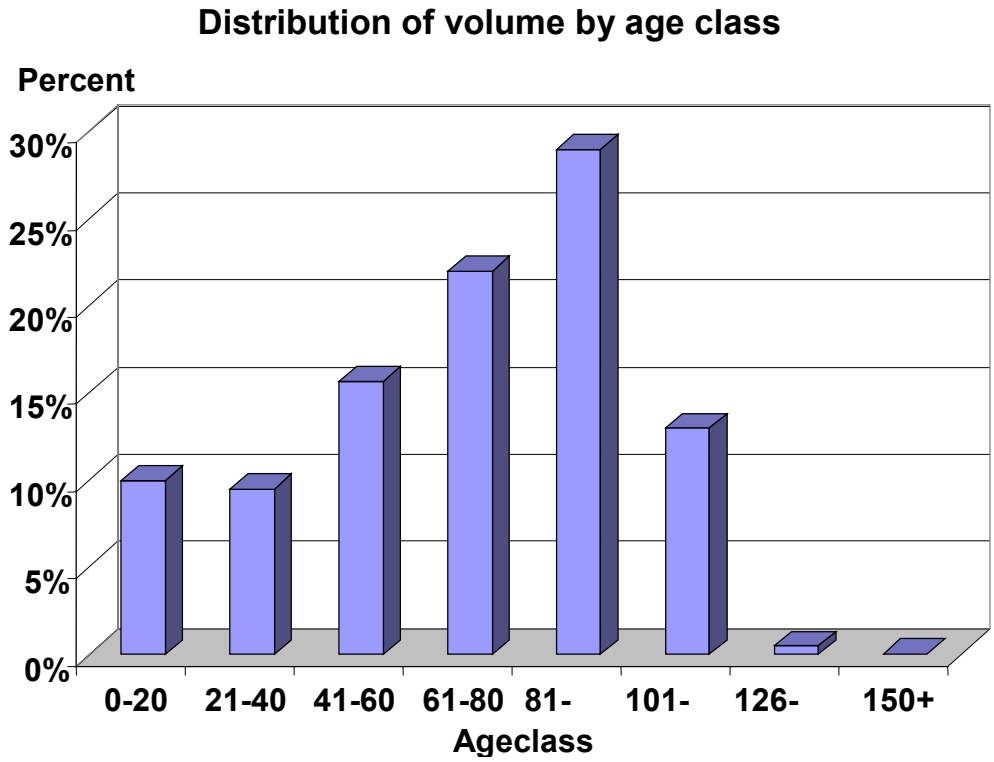


Figure 4.2-1. Distribution of volume by age class (% / age class).

Limitations of the estimates must be known to know how the data should and should not be used. The data for Skröven can e.g. be used for forestry applications such as making summaries of volumes or age class distributions over certain areas or as identification of e.g. high volume stands to add as potential nature reserves. Repeated estimations will serve as efficient monitoring of the variable mentioned.

The estimations for Skröven were carried out at the Swedish University of Agricultural Sciences (SUAS) at the cost of 25 000 SEK. In the case of Skröven (280 000 ha) this means 0,09 SEK/hectare. The cost is not so dependent on the size of the area but on the number of satellite scenes that are used. Estimations are done for the whole scene after which results for the area of interest need to be extracted. In this case 2 scenes were needed to cover Skröven. The University already had the two Satellite scenes needed to cover Skröven available. For this reason the costs refer mainly to the work conducted. If the scenes would have had to be acquired, approx. 25 000-30 000 SEK should be added to the costs.

The study and results are available in the report *Satellite imagery as a basis for assessing forest variables* (Söderberg 2002a). The report can be obtained from the National Board of Forestry or downloaded from the project web site.

4.3. Enforma-analysis

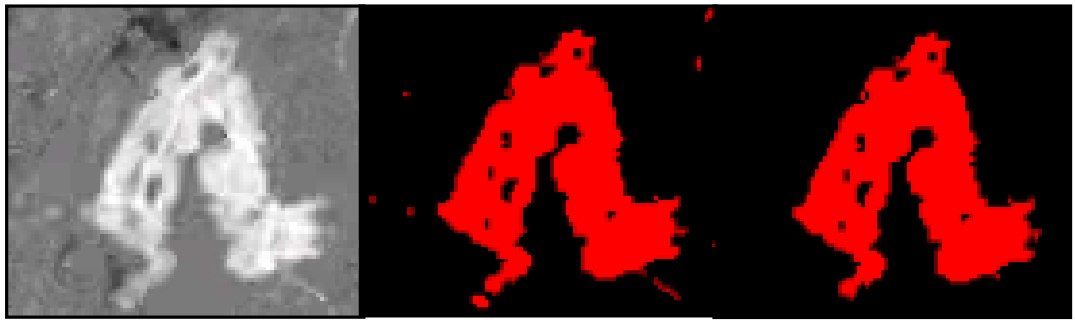
The ENFORMA application is the result of a 3-year project that has focused on the development of operational methods and tools using digital satellite imagery in an integrated GIS-system environment to follow-up forestry activities. It has primarily been developed for forestry authorities executing their responsibilities in

monitoring the activities of forest owners to enforce legal forestry and environmental requirements.

The ENFORMA Prototype is incorporating basic user specified functions for enabling semiautomatic mapping and monitoring of forest changes and status.

When detecting cuttings, two satellite images with a time interval between acquisition dates were used. Also a forest mask and two cloud masks were acquired. The forest mask makes the software delimit the search for changes to forest areas. The cloud mask makes a better relative calibration with histogram matching. The cloud mask prevents the user from interpreting changes caused by clouds and cloud shadow as actual changes in the forest.

By thresholding the difference image it is possible to derive a felling layer and then also to remove small areas from the layer. Single tree or very small cuttings, smaller than 0.2 ha cannot be detected correctly. Finally the result can be converted to a vector file (ArcView Shapefile).



The difference image. The felling layer after thresholding the differences image. All small areas removed.

Figure 4.3-1. Visualisation of the steps from a difference image to a GIS clear-cut layer.

In the Skröven area the method was used to find the location and size of all clear-cuts for the past 10 years. The results show that approx. 600 hectares per year have been harvested. The application can also be used for detection of pre-commercial thinning and soil scarification..

The method proved efficient also in the detection of other changes in the forest. It can be a problem though to determine what these changes are. Examples of changes possible to detect but difficult to label are; soil scarification, thinnings or needle discoloration by e.g. infections of *gremeniella abietina*

The cost for the Enforma analysis covering 1991-2000 are estimated at 20 000 SEK including the subsequent work with confirmation of felling areas either by field checks or by contacting contractors, local staff at RFB etc. To this sum should be added the costs for satellite scenes. In an operational phase the annual cost for identifying single year changes would be 8 000-10 000 SEK for the Skröven area. The costs for two satellite scenes at approx. 12 000-15 000 apiece should be added.

The study and results are available in the report *Satellite imagery as a basis for assessing forest variables* (Söderberg 2002a). The report can be obtained from the National Board of Forestry or downloaded from the project web site.

4.4. Impact of forestry operations on the reindeer forage potential

The forest of the Skröven area is used simultaneously by two different branches of business; forestry and reindeer herding. This economic bi-functionality sets a mark on large areas of forest in middle and northern Sweden. The branches have an impact on each other and there is a demand to quantify some of the effects. In an attempt to quantify the effects of forestry operation upon the reindeer forage potential in the forests, the results from the kNN and Enforma studies has been combined with other existing data in a new way.

The focus in the study has been on changes in grazing potential, notably ground lichen fodder after final felling. By changes in potential is here meant what would be the likely direction of change in lichen fodder after an operation. No data on the actual amount of lichens in the area is available and it could not be estimated through remote sensing.

Through Enforma analysis the clear-cut areas are delineated and then classified by the operations carried out; fellings with/without seed trees and soil scarification. The digital vegetation map was used to assign vegetation types to all delineated areas. The project team constructed a scheme on the short-term effects on growth of reindeer lichens (typically Cladina Abuscula) by the operation carried out and the initial vegetation type. The scheme is based on studies of literature and verified with knowledge from local reindeer herders. All delineated areas were subject to marking to three classes in the scheme; positive effect, no effect or negative effect.

The results showed that out of the fellings conducted between 1990 and 1999, only about 10 % of the fellings carried out had a negative effect on the potential for reindeer forage. A positive effect was estimated on 20 % of the area. On the remaining 70 % the results indicate that the fellings have had no effect. In field checks of the results it has been concluded that the vegetation change scheme is accurate on dry land. On mesic or wet land, it seems as more variables would need to be included to make the estimation of changes more accurate. By continuously repeating the assessment, changes can be monitored.

An advantage of the method is that it can be used both to assess the historic and future effects of forestry operations. Areas strongly affected in the past can be avoided or, if favourable, fellings can be concentrated leaving other areas less affected. Thematic maps, easily created in the GIS software, are accessible formats for distributing results.

In the study, a large portion of resources was used for literature studies and consultations with researchers and the local Sami villagers. The cost for carrying out the analysis after the methodology had been designed were approx. 12 000-14 000 SEK. This does not include the necessary kNN-estimations and Enforma-analysises described in previous chapters

The study and results are available in the report *Implications of forestry measures for reindeer husbandry* (Söderberg 2002b). The report can be obtained from the National Board of Forestry or downloaded from the project web site.

4.5. Economic importance of forests in rural areas

A case study was carried out in the Skröven area aiming to develop and test an interview based method to estimate the economic values derived from the forest for people living in sparsely populated areas. With economic value is here meant employment within forestry and forest industries, revenues from selling wood from privet forests as well as other uses that may be assigned an economic value. All uses are quantified in SEK.

The different uses of the forest were grouped into four categories:

1. The forest or forestry as a source of income
   (includes timber production from private forests, wages from forest based industries)
2. The forest as environment for leisure time
   (includes recreational values and product value from such activities (meat from hunting etc.))
3. The forest as housing environment
   (Benefits from living in/near forests)
4. Other values
   (appreciation of nature as environment, existence of plants and animals or historic-/cultural values etc.)

Members of ten households in the village Skröven and neighbouring villages were interviewed and asked to estimate the values of these categories. An introductory letter describing the study and its aims preceded the interviews, giving the participants a chance to prepare. A general discussion on each household's different uses of the forest started the interviews. The participants were then asked to rank the categories and give them each relative values. The interviewer made a rough estimate of absolute values based on the discussion and ranking. The results and their reasonableness were discussed.

The average values of forests for all household are estimated at 121 000 SEK annually. Approximately 45 % of this are income whilst the remaining 55 % are divided quite equally amongst the other groups. The variations between household were high. Not surprisingly, the variance in income was larger than the variance in other groups.

From the value of the forest as environment for leisure time, the product value is separated from the recreational value. In the study, only 2 % of the total leisure time value relates to product value (game meat, berries, mushrooms etc.).

Although there are many uncertainties about the valuation of benefits the conclusion is that the method works and produces interesting results. A natural way forward is using the experiences to develop a postal questionnaire. This could

make it possible to do surveys in larger scale. The results can also be used for developing a new indicator under Criterion 6.

The total cost of the study was 66 000 SEK. The interviews and the preparations directly linked to carrying out the interviews cost 8 000 SEK.

The method and results from the study are available in the report *Forest used and its economic value for inhabitants of Skröven and Hakkas in Norrbotten* (Wilhelmsson 2002). The report can be obtained from the Swedish University of Agricultural Sciences in Umeå or downloaded from the project web site.

4.6. Inventory of three-toed woodpecker

The inventory of three-toed woodpecker were carried out in the Vällen demonstration area in March-June in 1993, and repeated within this project in 1999.

Recordings of woodpecker drumming were replayed in the field to increase the chance of discovering all specimens. Many areas were visited several times during the survey.

In 1993, the landscape was divided into habitat categories based on analysis of aerial photos (IRF, scale 1:10 000, from 1992) and field surveys. Seven habitat classes were created: 1) coniferous forests older than fifty years, 2) wet forests, 3) deciduous forests, 4) young forests (less than fifty years), 5) regeneration areas, 6) agricultural areas, and 7) open water. The area of old-growth forest was also estimated. In 1999 the landscape was reclassified regarding areas harvested during the period 1993-1999. Forest dominated the area (approx. 90%) while open water and wetlands made up 7%.

In the 1993 inventory, 15 specimen of three-toed woodpecker were found (six pairs and three single birds). In the second inventory (1999) only eight specimen (three pairs and two single females) were found. The number of home ranges was constant (three pairs) in large, continuous old-growth forest areas (nature reserves), but the species declined in the remaining part of the studied area, from eight specimen in 1993 to one specimen in 1999.. Considerable harvesting had taken place in or adjacent to the home ranges of three pairs that had disappeared by 1999. At one site, where one breeding pair was recorded in 1993, 11 ha of wet forest had been cut. A total of 860 ha (approx. 16% of forest older than 50 years) was logged in the study area between 1993 and 1999, including ca 160 ha old-growth forest and 30 ha wet forest. A statistical analysis of the conditions in 1999 indicated that between 80 and 130 ha of old-growth forest is required for one breeding pair three-toed woodpecker.

The amount of dead wood was estimated in seven old-growth forest stands, covering four home ranges where breeding three-toed woodpeckers had been recorded at least once during 1993-1999. The mean volume of standing and fallen dead wood (excluding bark) was 27.5 m^3 per ha (range: 8.6-49.8 m^3 per ha). The volume of fallen dead wood was always larger (1,6- 5,6 times) than the volume of standing dead wood. The proportion of dead wood was 13 % (range: 5-30 %) of the total wood volume.

We also studied foraging preferences of the three-toed woodpeckers. The dead wood was classified into four categories, spanning from recently dead trees with a fresh bark surface (category 1) to almost completely decayed wood (category 4). The three-toed woodpecker foraged mainly on dead spruce of low decay (categories 1-2). The mean volume of dead spruce in categories 1-2 was 10.5 m3 ha-1 (range: 5.0-15.8 m^3 per ha).

The method and results from the study are available in the report *Methods to monitor three-toed woodpecker* (Amcoff & Eriksson 2002). The report can be obtained from the Swedish Environmental Protection Agency or downloaded from the project web site.

4.7. Inventory of dead wood

An inventory of dead wood was made in the Vällen area. The purpose of the inventory was to test a new method to assess the amount of dead wood in a landscape perspective. The demand on the new method was simplicity, high accuracy and adaptation to normal forest measuring methods. It was also designed to be able to relate to the results of the National Forest Inventory.

An important aim for the study was to be able to present results for different stand age classes using the same unit for all types of dead wood. The field inventory was made in squares, 500x500 meters. The corners of the squares were related to the squares in the economic map of Sweden in scale 1:10 000. The squares were selected by random and they represented 5-10 % of the productive forest land of a total of 5 000 ha. Within the sampled squares all dead wood was measured. The test area of 5 000 ha were chosen subjectively as a representative part of the Vällen area (approx. 15 000 ha) Two persons carried out the field inventory. The selected squares were positioned in the forest using a handheld GPS.

Before initiating the fieldwork, each stand was delineated in a map. The stand-data was transformed into a format specially developed for the inventory. In the test, paper copy forms were used for data collection. A handheld computer would have simplified the calculation process but it would also have required more development work.

Normal forestry measuring instruments were used to assess the diameter and length (height) of each substrate. Complementary, tree species, substrate type and level of decomposition were measured. All calculations were made in the office.

The results differed from the average in the region as measured by the NFI. In Vällen amount of dead wood were significantly lower. The method can be used when information is needed for smaller areas than what is possible to assess through NFI. The number of sampled squares and the size of the squares can be altered within the inventory concept.

A total of 300 ha were inventoried. A little less than 500 m^3 under bark of dead wood was found. The cost for the field survey was 280 SEK/ha. Related to the test area this means a cost of approx. 15 SEK/ha. On an average it should be possible for two persons to measure two squares per working day.

The method and results from the study are available in the report *A method to monitor the volume of dead wood* (Nissilä & Didrik 2002a). The report can be obtained from the Swedish Environmental Protection Agency or downloaded from the project web site.

4.8. Inventory of woodliving insects

The inventory focused on red-listed, wood living (saproxylous) beetles (Coleoptera) and their relation to different old-growth forest substrates (snags, fallen logs, old and burnt trees of aspen, birch, oak and spruce). We sampled beetles by the aid of window traps at 15 sites, located in the Vällen area May to August 1999 and 2000. Four traps (windows 30.5 x 40 cm) were used at most sites, but in some cases ten smaller traps (windows 10 x 15 cm) were used instead. As a complement, we actively searched for certain species at each location. The time spent on this project amounts to a total of 1 044 hours, to the cost of 167 000 SEK.

In total 23 095 specimen of 838 identified taxa were trapped during the two-year study. The species caught in traps include 87 red-listed species. In total 96 red-listed species was found, representing 72% of all the red-listed wood living beetles ever recorded in the county of Uppsala. One species, named Dorcatoma janssoni, was new to science, and 63 red-listed species were recorded for the first time in the Lake Vällen area. Two species are listed in EU's Habitat Directive: Cucujus cinnaberinus and Xyletinus tremulicola (a Fennoscandian endemic).

Red-listed wood living beetles were trapped at all 15 sites, indicating that some species occur throughout the Lake Vällen area, wherever suitable substrate is present or created. However, other species occurred only at sites characterised by long continuity and a certain volume of a specific woody substrate.

Timber cutting has taken place on at least three locations the last 20 years where the endangered Ceruchus chrysomelinus was recorded. The species will probably vanish from these sites as soon as the coarse, fallen spruce logs have decayed, and it is probable that it will be found only in protected old-growth forests in the future.

We observed that habitats with many red-listed species had 10-30 times more dead wood than the average forest landscape in the Lake Vällen area. Thus, it is the old-growth forests and nature reserves that play a decisive role for biodiversity of wood-living insects in this area.

Several red-listed species were found in association with large aspens on, or at the edge of, cut areas. We found fire dependent species on burnt wood, despite the lack of continuity of such substrates in the Lake Vällen area. These observations indicate that environmental consideration in forestry operations as well as newly restored dead wood or fire in man-made stands is important for the lower fauna. Many red-listed wood living species disperse easily into areas with newly formed, suitable substrates. Therefore, they are a useful for indicating the success of active management actions in forestry, such as creation of snags and burning of forest. However, among species with low dispersal ability, closeness to cores of old-growth forests is important for colonisation of dead wood in restored stands.

Deciduous trees left after final fellings will for some time function as valuable refuges for some species. The character of the stand prior to cutting decides to a high degree the value of the remaining trees. To attain knowledge of population trends and biodiversity in forests, repeated long-term studies are necessary. For this purpose, areas with a long history of documentation of saproxylous insects are of particular interest.

It is concluded that the use of window traps is generally an effective method, giving a good view of the tree-dependent fauna in a landscape. However, some species, either very rare or with behaviour unsuitable for window trap sampling may need to be searched actively (e.g. Ceruchus chrysomelinus)

We recommend this study to be repeated in approximately 10 years. The study should also include other habitats. For simplification, some groups of beetles could be excluded, e.g. the generally difficult and large family of short wings (taphylinidae).

Many of the species occur in several countries within EU. Eleven are red-listed in Sweden, Denmark and Finland, while 45 species are red-listed in Sweden and either Denmark or Finland.

The method and results from the study are available in the report *Methods to monitor woodliving insects* (Eriksson 2002). The report can be obtained from the Swedish Environmental Protection Agency or downloaded from the project web site.

4.9. Inventory of buffer zones by watercourses

An inventory of forest buffer zones towards shores of waterbodies has been carried out in the Vällen area. The aim was to develop and test a rational remote sensing method to assess the occurrence and features of buffer zones to water. The inventory was eventually tested on over 70 km of shorelines.

The study was made in aerial photographs with an analytical stereo plotter – supported by 2 computers. All zones were classified according to width (in 8 classes up to 50 m) and basic features. An area is considered a buffer zone if it the mean height of the forest stand exceeded 12 m.

In the study area, 48.3 km of the shoreline was forest land of which 4.2 km lacked a buffer zone. This means that less than 10 % of the shorelines in the forests lack a buffer zone. If the length without a buffer zone is related to the length affected by final felling it corresponds to little less than 25 % of the shoreline. Registration of tree height in the zones makes it possible to see that buffer zones are left more frequently in later years than previously.

The method and results from the study are available in the report *Methods for inventory of buffer zones along lakes and rivers* (Löfgren & Ohlsson 2002). The report can be obtained from the Swedish Environmental Protection Agency or downloaded from the project web site.

4.10.Cultural values

A large portion of the preserved cultural relics is found in the forest. Many are spoiled or damaged in forestry operations often due to the fact that they are unknown. A sub-study has been carried out in the Vällen area aiming to describe methodology for:

- Identifying risk areas connected with clearing cairns
- Remote sensing analysis and mapping of ancient remains in the forest, including establishing an inventory model for forestry planning in the risk areas

In identifying risk areas, study of existing archaeological data and maps combined with older maps and subsequent fieldwork pointed out criteria for finding risk areas. For instance clearing cairns located solitary or in small groups in the crown of a hill or moraine indicates potential for other ancient remains in the vicinity

For the purpose of the study, an archaeological area was chosen where final felling and subsequent planting had been carried out prior to the project. The area under investigation has also functioned as a reference area for additional studies in other parts of the country

The study involved photo documentation from helicopter, aerial photography and digitalisation of basic data, inventory in the field , mapping and analysis within the chosen area. Within the area where the official map showed only about ten graves, the study localised 178 new objects, including graves, houses, foundations, clearing cairns and tilled fields.

A working model is proposed consisting of the following stages; 1) Scrutinising economic map, scale 1:10 000, 2) Scrutinising older maps, 3) control with local population, 4) field work. It is assumed that landowners can make the control in an early stage of planning and, if necessary, contact proper authorities for detailed inventories.

The study and results are available in the report *Preservation of ancient remains in forests-methodology for long term planning of sustainable forestry*(Gustafsson 2002). The report can be obtained from the Swedish Environmental Protection Agency or downloaded from the project web site.

4.11. Possibilities for sustainable forestry in a landscape perspective

In the Vällen area, a study was made aiming to create a forest description useful for planning and follow-up of sustainable forestry in a landscape perspective. This was done from the idea that sustainability with regard to biological diversity can't be achieved at single holding level. A common feature of the forest owners in the Vällen area is that they have some kind of forest management plan. Many forest variables used in these plans also have relevance for biological diversity. The management plans were therefore used as base material for this study. The variables derived from the plans include; Stand age, standing stock, distribution of tree species, cutting class, site index, size of area etc.

Different owners of forest in Vällen have different management. Three types of plans were used to cover the forest of the area. Forest stand data from two large forest owner and data from the Regional Forestry Board inventories of all small scale private forestry (1982 and 1992). In the study, data from different plans has been harmonised and put into a landscape covering GIS planning system.

The study resulted in methods to gather, transform, update, register and disseminate forestry data in a landscape perspective. Two phases of the work can be distinguished; 1) Gather and conform data, 2) produce well arranged output.

When creating output from the study, emphasis was put on clearness of conditions in a geographical context. A number of thematic maps of e.g. site index, stand age distribution, cutting classes and tree species distribution was created to complement the statistics.

The information in tables and maps provides for an overview of the landscape features and paves the way for planning over ownership borders.

The study and results are available in the report *A method to show the possibilities for sustainable forestry in a landscape perspective* (Nissilä & Didrik 2002b). The report can be obtained from the Swedish Environmental Protection Agency or downloaded from the project web site.

5. Discussion and conclusions

5.1. Current follow up insufficient

The gap-analysis has shown gaps in the current follow-up system in Sweden and the insufficiency of indicators or indicator definitions. The lack of good indicators was pinpointed in the fields of *biological diversity*, *non-wood forest products, protective functions* and *socio-economic functions and conditions*. *Forest resources*, *wood-production* and to some extent *health & vitality of forests* were found to have fairly relevant indicators. In many cases, low validity of indicators coincides with low reliability in the existing monitoring method. This does not necessarily mean that the methods available are not suited for assessing data in a particular field but rather that the demand (indicator definition) may be unclear.

The NFI has a very central position in monitoring in Sweden. As this continuos inventory is covering the whole country every year it is possible to introduce new variables with short notice and to produce estimates after just a few years. Many of the indicators currently not well covered could, given a relevant definition, be assessed in the NFI at a very low marginal cost. Exceptions are indicators with spatial elements or indicators concerning elements that occur with low frequency in the forest. Also other monitoring or administrative systems could be used for indicator assessment after minor alterations.

5.2. Demonstration of methods

The demonstration efforts carried out in Skröven and Vällen have generated a large amount of inventory results and methodologies. Some methods demonstrated, e.g. inventory of dead wood, have been rather intense and costly. By small alterations of these methods, their intensity can be increased or decreased to fit other needs for accuracy.

In the systematic inventory of wood living insects, the number of species caught was larger than expected –including a large number of currently red listed species. It may well happen that the results would be similar for other similar areas. If so, it might have implications on national red lists. The relatively high costs for this kind of intense inventory suggest that the results are matched against other variables, e.g. forest structures, which can be monitored cost efficiently in larger areas. The intense monitoring/inventories is needed to create strong correlation between forest structures and changes and the (potential for) presence of certain species of interest.

The remote sensing technique demonstrated to monitor forest buffer zones to shores of water is judged to be efficient and accurate. In Sweden where eutrophication of the sea (notably the Baltic Sea) is a major environmental problem, this is highly interesting. The method can be used cost efficiently in larger scale without any major alterations.

Locating regeneration areas using satellite images has been proven an efficient and uncomplicated method. Earth observation data in combination with results

from the National Forest Inventory (NFI) can also be used to estimate several forestry variables in smaller areas than is possible using NFI data alone. Continuos assessment are needed for monitoring of these variables. The Swedish Forestry Administration is currently introducing the Enforma technique to be an operational tool for finding regeneration areas and other major changes in the forest.

The combination of existing data from many sources in a GIS has been a useful tool for indicator development and data acquisition. In the example of assessing the impact on reindeer lichen forage potential by regeneration fellings, existing data is used in a new way. Thematic maps, easily created in the GIS, can be used for dissemination of the results and, with simple means, the access to information can be evened out between stakeholders.

The data gathering exercise carried out in Vällen proved that forest data in many formats from many landowners could be compiled. The landscape covering data will be very useful in a process of ecological landscape planning over ownership border to enhance efficiency in environmental considerations in forestry. Repeated compilation of data would be needed for monitoring purposes.

5.3. Monitoring system

Findings from the Gap-analysis made it evident that current monitoring in Sweden is not sufficient for monitoring of sustainability of forestry, neither at national, nor at sub national level.

A challenge would be to develop the system of indicators to suit the conditions in Sweden. Such a system should be comprehensive enough to cover most areas of sustainability and yet comprise of a workable set of indicators. The indicators would need very precise definitions. For creating an impact it would also need to be accepted among different stakeholders. This would need to be done parallel to setting target values or at least deciding upon desired directions of changes. The geographical dimensions adds complexity to the problem as indicators and targets as well as monitoring methods may vary between geographical scales.

When working with the indicators of the MCPFE process it has been an obvious problem that they are not well known in Sweden. The approach to sustainability in Swedish forest policy is derived from the same basis as the MCPFE indicators but the Swedish approach is quite different. Target setting has preceded development of indicators and improvement of monitoring methods. This means that the MCPFE indicators have not been used in national sustainability work so far.

It has been noted that the criterion approach of structuring sustainability is considered problematic and good discussions among fellow professionals in Sweden have been restrained for this reason.

6. Dissemination

Already the project name "Demonstration of Methods to Monitor Sustainable Forestry" indicates the importance of dissemination from the project. The idea of a demonstration project is that results and experiences are shared with others. This emphasises a thorough documentation of all work and active dissemination during and after the project. In this chapter some of the dissemination activities are described and reports produced within the Swedish component are listed.

6.1. International workshop in Vällen

The first in a series of 5 international workshops within the project were held in Gimo, Sweden in the fall 1998. Participants from eleven countries were present at the workshop. Every country within the project has since then arranged workshops to give interested people from the European countries a chance to follow the project progress. The Swedish component has participated in all of these workshops and presented the status on national progress.

The first workshop focused on information about the project and advice from the participants on the work-plan and future activities. Each country presented its national part of the project. Another mission was to demonstrate Swedish methods to monitor sustainable forestry. The Vällen demonstration area was used for field demonstrations of methods.

The following methods and their relevance for sustainable forestry were demonstrated either in the field at excursions or through presentations at the workshop:

- The National Forest Inventory
- The Swedish Survey of Forest Soils and Vegetation
- The Polytax Inventory
- The Kotten information system
- The Inventory of Forest wetlands
- Remote sensing to check if virgin-like forest is cut
- Questionnaires as a method to report final felling of areas that host red-listed species
- Ecological Landscape Planning

The workshop agreed to use the platform from the Helsinki process and its definition of sustainable forestry. It was also concluded that the project should not work on a European level, only use the Pan-European Criteria and Indicators as a basis for the national work. Proceedings from the workshop are available at www.svo.se/life. A brief description of forest managament planning in Sweden are included in the proceedings.

6.2. National seminars

For dissemination of final project results within Sweden, seminars and excursions were planned for in Skröven and Vällen. The Vällen seminar was a 2-day exercise including field-visits. Methods used and the results were discussed. The Vällen seminar had a national perspective, meaning that results from both Skröven and Vällen were presented as well as common activities and conclusions. The seminar attracted about 50 participant from authorities, universities forestry companies and NGO:s. A representative of the Finnish partner was invited to present findings from the Finnish part of the project.

The seminar in Skröven focused on results from this demonstration area. Due to a limited number of participants the excursion part was cancelled. Methods and results were discussed among project staff and participants.

6.3. Publications

This final report is the main Swedish publication of results and findings in the project. It aims to give a broad picture of the work carried out in Sweden and overall conclusions. A brief description of the Gap-analysis is included. A final report covering the work and conclusions from the Vällen area is also prepared.

For interested readers, a series of technical reports are being produced which deals with the details of each separate activity carried out within the Swedish part of the project. The details of the Gap-analysis are covered in the international report produced jointly between all partners of the project (Sollander 2001).

Reports with the following titles are/will be published in Sweden. Most reports are written in Swedish with a comprehensive summary in English:

- Demonstration av metoder för monitoring av uthålligt skogsbruk inom Vällenområdet i Uppland (Demonstration of methods to monitor sustainable forestry in the Lake Vällen area).
- Bevarande av fornlämningar i skogsbruk –metodik för långsiktig planering av ett hållbart skogsbruk (Preservation of ancient remains in forests – methodology for long term planning of sustainable forestry).
- Metodik för inventering av vedlevande insekter (Methods to monitor woodliving insects) .
- Metodik för beskrivning av förutsättningarna för uthålligt skogsbruk på landskapsnivå (A method to show the possibilities for sustainable forestry in a landscape perspective).
- Metodik för inventering av död ved (A method to monitor the volume of dead wood).
- Metodik för inventering av skyddszoner vid sjöar och vattendrag (Methods for inventory of buffer zones along lakes and rivers).
- Metodik för inventering av tretåig hackspett (A method to monitor three-toed woodpecker).
- The use and economic value of the forest for people in Skröven and Hakkas in Norrbotten

- Satellitbildsbaserade skattningar av skogliga variabler (Satellite imagery as a basis for assessing forest variables).
- Skogliga åtgärders påverkan på förutsättningarna för renbete (Implications of forest measures for reindeer husbandry).

6.4. Media attention

The project finding has rendered some media attention especially in connection with the international workshop and the excursions. Articles have appeared in several newspapers and magazines such as Upsala Nya Tidning, Skogseko, Miljöaktuellt etc.

The discovery of a new insect species rendered special attention, not only in Sweden but also with entomologists in other countries. Swedish news agency TT distributed the news to Swedish media. The total extent of publicity rendered by this is not known to the project management. Local television news in Uppland covered the story and made a visit to the Vällen area.

6.5. Other dissemination activities

In November 2001 a presentation of the project was made in a special EU/LIFE-project annex to Skogseko. The annex presented EU/LIFE sponsored projects in which the Swedish Forestry Administration has taken an active part. Skogseko and the annex were distributed in over 270 000 copies reaching all private forest owners and most of the forest related organisations in Sweden.

The natural resource department at the Swedish Environmental Protection Agency made a study tour to Vällen and was informed of the work conducted there.

In Vällen, a number of information boards will be put up. The boards aim to present the Vällen area with maps, information on the LIFE-project, descriptions of the landscape, forestry, flora & fauna, protected areas, habitats of special interest for biodiversity etc. In all, 5 boards will be put up at locations where many people may pass.

During the project, the international project manager established a list of interested professionals. This group has been continuously updated on project progress and has been invited to the international workshops and final seminar.

The Internet provides an important tool for project dissemination. Information about the project and all reports produced is published on the project web site.

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Söderberg P. 2002b. Manuscript. Skogliga åtgärders påverkan på förutsättningarna för renbete (In Swedish with English summary).

Wilhelmsson E. 2002. Forest use and it's economic value for inhabitants of Skröven and Hakkas in Norrbotten. Department of forest resource management and geomatics, SLU Umeå. Working paper 91 2002. 22 p. ISSN 1404-1204.

Annex 1. Project staff

Project steering group

The steering group has had an overall responsible for the Swedish component. Each project partner sent 2 representatives to form the steering group. Mr. Stig Ohlsson and Mr. Sune Sohlberg represented the Swedish Environmental Protection Agency. The National Board of Forestry were represented by Dr. Sven A. Svensson and by the project manager (from 2000-05) Mr. Karl Gustafsson (previously by Mr. Erik Sandström and Mr. Hans Liedholm).

Project manager

The project manager has had responsibility for planning and execution of the Swedish project as well as national correspondence with the international project manager. The project manager co-ordinated the work with the Gap-analysis. This post were held by Mr. Erik Sandström, National Board of Forestry (to 1999-01), Mr. Hans Liedholm, Regional Board of Forestry in Västra Götaland (from 1999-02) and Mr. Karl Gustafsson, National Board of Forestry (from 2000-05).

Demonstration area staff

Many professionals from the partners and other organisations carried out the demonstration task in the two demonstration areas. Below are listed project staff that has contributed substantially to the demonstration task.

Skröven
Dr. Mats Nilsson, University of Agricultural Sciences, Umeå
Ms. Tina Nilsson, Administrative County Board of Norrbotten
Mr. Inge Lahdenperä, Regional Forestry Board in Norrbotten
Mr. Lars-Thomas Persson, Gällivare skogsameby
Mr. Tuomo Raunistola, Administrative County Board of Norrbotten
Ms. Heather Reese, University of Agricultural Sciences, Umeå
Mr. Peter Söderberg, Regional Forestry Board in Norrbotten (Demonstration area manager)
Mr. Erik Wilhelmsson, Swedish University of Agricultural Sciences
Mr. Kenny Ärlebrand, Regional Forestry Board in Norrbotten

Vällen
Ms. Siw Almroth, Regional Forestry Board in Mälardalen
Mr. Martin Amcoff, Uppland Foundation
Mr. Rickard Andersson, Höör
Mr. Ulf Didrik, Regional Forestry Board in Mälardalen
Mr. Bengt Ehnström, Swedish Threatened Species Unit
Ms. Linda Eriksson, Korsnäs AB
Mr. Pär Eriksson, Uppland Foundation
Ms. Maria Forslund Administrative County Board in Uppsala
Mr. Per Frölund, The Uppland County Museum
Mr. Jan Helmer Gustafsson, Administrative County Board in Uppsala.
Mr. Hans Göthberg, The Uppland County Museum

Mr. Göran Hansson, Dannemora
Dr. Mats Jonsell, Baggforsk, Uppsala
Ms. Katarina Karlsson, Administrative County Board in Uppsala
Mr. Stig Lundberg, Luleå
Mr. Lars Lundgren, Regional Forestry Board in Mälardalen
Mr. Jan Lundquist, Administrative County Board in Uppsala
Mr. Tommy Löfgren, NaturGis AB
Mr. Sören Nissilä, Regional Forestry Board in Mälardalen
Mr. Stig Ohlsson, Swedish Environmental Protection Agency (Demonstration area manager)
Mr. Göran Sjöblom, Korsnäs AB
Mr. Sune Sohlberg, Swedish Environmental Protection Agency
Mr. Sebastian Sundberg, Uppsala University
Mr. Bent Syse, The Uppland County Museum
Mr. Henrik Wallin, Uppsala

Av Skogsstyrelsen publicerade Rapporter:

1985 Utvärdering av ÖSI-effekter mm
1985:1 Samordnad publicering vid skogsstyrelsen
1985:2 Beskärning i tallfröplantager
1986:1 Bilvägslagrat virke 1984
1987:1 Skogs- och naturvårdsservice inom skogsvårdsorganisationen
1988:1 Mallar för ståndortsbonitering; Lathund för 18 län i södra Sverige
1988:2 Grusanalys i fält
1988:3 Björken i blickpunkten
1989:1 Dokumentation – Storkonferensen 1989
1989:2 Bok, ek och ask inom svenskt skogsbruk och skogsindustri
1990:1 Teknik vid skogsmarkskalkning
1991:1 Tätortsnära skogsbruk
1991:2 ÖSI; utvärdering av effekter mm
1991:3 Utboträffar; utvärdering
1991:4 Skogsskador i Sverige 1990
1991:5 Contortarapporten
1991:6 Participation in the design of a system to assess Environmental Consideration in forestry a Case study of the GREENERY project
1992:1 Allmän Skogs- och Miljöinventering, ÖSI och NISP
1992:2 Skogsskador i Sverige 1991
1992:3 Aktiva Natur- och Kulturvårdande åtgärder i skogsbruket
1992:4 Utvärdering av studiekampanjen Rikare Skog
1993:1 Skoglig geologi
1993:2 Organisationens Dolda Resurs
1993:3 Skogsskador i Sverige 1992
1993:4 Av böcker om skog får man aldrig nog, eller?
1993:5 Nyckelbiotoper i skogarna vid våra sydligaste fjäll
1993:6 Skogsmarkskalkning – *Resultat från en fyraårig försöksperiod samt förslag till åtgärdsprogram*
1993:7 Betespräglad äldre bondeskog – *från naturvårdssynpunkt*
1993:8 Seminarier om Naturhänsyn i gallring i januari 1993
1993:9 Förbättrad sysselsättningsstatistik i skogsbruket – *arbetsgruppens slutrapport*
1994:1 EG/EU och EES-avtalet ur skoglig synvinkel
1994:2 Hur upplever "grönt utbildade kvinnor" sin arbetssituation inom skogsvårdsorganisationen?
1994:3 Renewable Forests - Myth or Reality?
1994:4 Bjursåsprojektet - *underlag för landskapsekologisk planering i samband med skogsinventering*
1994:5 Historiska kartor - *underlag för natur- och kulturmiljövård i skogen*
1994:6 Skogsskador i Sverige 1993
1994:7 Skogsskador i Sverige – *nuläge och förslag till åtgärder*
1994:8 Häckfågelinventering i en åkerholme åren 1989-1993
1995:1 Planering av skogsbrukets hänsyn till vatten i ett avrinningsområde i Gävleborg
1995:2 SUMPSKOG – ekologi och skötsel
1995:3 Skogsbruk vid vatten
1995:4 Skogsskador i Sverige 1994
1995:5 Långsam alkalinisering av skogsmark
1995:6 Vad kan vi lära av KMV-kampanjen?
1995:7 GROT-uttaget. Pilotundersökning angående uttaget av trädrester på skogsmark
1995:8 The Capercaillie and Forestry. Reports No. 1-2 from the Swedish Field Study 1982-1988
1996:1 Women in Forestry – What is their situation?
1996:2 Skogens kvinnor – Hur är läget?
1996:3 Landmollusker i jämtländska nyckelbiotoper
1996:4 Förslag till metod för bestämning av prestationstal m.m. vid självverksamhet i småskaligt skogsbruk.
1996:5 Skogsvårdsorganisationens framtidsscenarier
1997:1 Sjövatten som indikator på markförsurning
1997:2 Naturvårdsutbildning (20 poäng) Hur gick det?
1997:3 IR-95 – Flygbildsbaserad inventering av skogsskador i sydvästra Sverige 1995
1997:4 Den skogliga genbanken (Del 1 och Del 2)
1997:5 Miljeu96 Rådgivning. Rapport från utvärdering av miljeurådgivningen
1997:6 Effekter av skogsbränsleuttag och askåterföring – *en litteraturstudie*
1997:7 Målgruppsanalys
1997:8 Effekter av tungmetallnedfall på skogslevande landsnäckor *(with English Summary: The impact on forest land snails by atmospheric deposition of heavy metals)*
1997:9 GIS–metodik för kartläggning av markförsurning – *En pilotstudie i Jönköpings län*

1998:1 Miljökonsekvensbeskrivning (MKB) av skogsbränsleuttag, asktillförsel och övrig näringskompensation
1998:2 Studier över skogsbruksåtgärdernas inverkan på snäckfaunans diversitet *(with English summary: Studies on the impact by forestry on the mollusc fauna in commercially uses forests in Central Sweden*
1998:3 Dalaskog - Pilotprojekt i landskapsanalys
1998:4 Användning av satellitdata – *hitta avverkad skog och uppskatta lövröjningsbehov*
1998:5 Baskatjoner och aciditet i svensk skogsmark - tillstånd och förändringar
1998:6 Övervakning av biologisk mångfald i det brukade skogslandskapet. *With a summary in English: Monitoring of biodiversity in managed forests.*
1998:7 Marksvampar i kalkbarrskogar och skogsbeten i Gotländska nyckelbiotoper
1998:8 Omgivande skog och skogsbrukets betydelse för fiskfaunan i små skogsbäckar
1999:1 Miljökonsekvensbeskrivning av Skogsstyrelsens förslag till åtgärdsprogram för kalkning och vitalisering
1999:2 Internationella konventioner och andra instrument som behandlar internationella skogsfrågor
1999:3 Målklassificering i ”Gröna skogsbruksplaner” - betydelsen för produktion och ekonomi
1999:4 Scenarier och Analyser i SKA 99 - Förutsättningar
2000:1 Samordnade åtgärder mot försurning av mark och vatten - Underlagsdokument till Nationell plan för kalkning av sjöar och vattendrag
2000:2 Skogliga Konsekvens-Analyser 1999 - Skogens möjligheter på 2000-talet
2000:3 Ministerkonferens om skydd av Europas skogar - Resolutioner och deklarationer
2000:4 Skogsbruket i den lokala ekonomin
2000:5 Aska från biobränsle
2000:6 Skogsskadeinventering av bok och ek i Sydsverige 1999
2001:1 Landmolluskfaunans ekologi i sump- och myrskogar i mellersta Norrland, med jämförelser beträffande förhållandena i södra Sverige
2001:2 Arealförluster från skogliga avrinningsområden i Västra Götaland
2001:3 The proposals for action submitted by the Intergovernmental Panel on Forests (IPF) and the Intergovernmental Forum on Forests (IFF) - in the Swedish context
2001:4 Resultat från Skogsstyrelsens ekenkät 2000
2001:5 Effekter av kalkning i utströmningsområden *med kalkkross 0 - 3 mm*
2001:6 Biobränslen i Söderhamn
2001:7 Entreprenörer i skogsbruket 1993-1998
2001:8A Skogspolitisk historia
2001:8B Skogspolitiken idag - en beskrivning av den politik och övriga faktorer som påverkar skogen och skogsbruket
2001:8C Gröna planer
2001:8D Föryngring av skog
2001:8E Fornlämningar och kulturmiljöer i skogsmark
2001:8F Ännu ej klar
2001:8G Framtidens skog
2001:8H De skogliga aktörerna och skogspolitiken
2001:8I Skogsbilvägar
2001:8J Skogen sociala värden
2001:8K Arbetsmarknadspolitiska åtgärder i skogen
2001:8L Skogsvårdsorganisationens uppdragsverksamhet
2001:8M Skogsbruk och rennäring
2001:8N Ännu ej klar
2001:8O Skador på skog
2001:9 Projekterfarenheter av landskapsanalys i lokal samverkan – (LIFE 96 ENV S 367) Uthålligt skogsbruk byggt på landskapsanalys i lokal samverkan
2001:10 Blir ingen rapport
2001:11A Strategier för åtgärder mot markförsurning
2001:11B Markförsurningsprocesser
2001:11C Effekter på biologisk mångfald av markförsurning och motåtgärder
2001:11D Urvalskriterier för bedömning av markförsurning
2001:11E Effekter på kvävedynamiken av markförsurning och motåtgärder
2001:11F Effekter på skogsproduktion av markförsurning och motåtgärder
2001:11G Effekter på tungmetallers och cesiums rörlighet av markförsurning och motåtgärder
2001:11H Ännu ej klar
2001:11I Ännu ej klar
2001:12 Forest Condition of Beech and Oek in southern Sweden 1999
2002:1 Ekskador i Europa
2002:2 Gröna Huset, slutrapport
2002:3 Project experiences of landscape analysis with local participation – (LIFE 96 ENV S 367) Local participation in sustaina ble forest management based on landscape analysis
2002:4 Landskapsekologisk planering i Söderhamns kommun
2002:5 Miljöriktig vedeldning - Ett informationsprojekt i Söderhamn
2002:6 White backed woodpecker landscapes and new nature reserves
2002:7 ÄBIN Satellit

Av skogsstyrelsen publicerade Meddelanden:

1985:1 Fem år med en ny skogspolitik
1985:2 Eldning med helved och flis i privatskogsbruket/virkesbalanser 1985
1986:1 Förbrukningen av trädbränsle i s.k. mellanskaliga anläggningar/virkesbalanser 1985
1986:3 Skogsvårdsenkäten 1984/virkesbalanser 1985
1986:4 Huvudrapporten/virkesbalanser 1985
1986:5 Återväxttaxeringen 1984 och 1985
1987:1 Skogsvårdsorganisationens årskonferens 1986
1987:2 Återväxttaxeringen 1984 – 1986
1987:3 Utvärdering av samråden 1984 och 1985/skogsbruk – rennäring
1988:1 Forskningsseminarium/skogsbruk – rennäring
1989:1 Skogsvårdsorganisationens årskonferens 1988
1989:2 Gallringsundersökningen 1987
1991:1 Skogsvårdsorganisationens årskonferens 1990
1991:2 Vägplan -90
1991:3 Skogsvårdsorganisationens uppdragsverksamhet – Efterfrågade tjänster på en öppen marknad
1991:4 Naturvårdshänsyn – Tagen hänsyn vid slutavverkning 1989–1991
1991:5 Ekologiska effekter av skogsbränsleuttag
1992:1 Svanahuvudsvägen
1992:2 Transportformer i väglöst land
1992:3 Utvärdering av samråden 1989-1990 /skogsbruk – rennäring
1993:1 Skogsvårdsorganisationens årskonferens 1992
1993:2 Virkesbalanser 1992
1993:3 Uppföljning av 1991 års lövträdsplantering på åker
1993:4 Återväxttaxeringarna 1990-1992
1994:1 Plantinventering 89
1995:1 Skogsvårdsorganisationens årskonferens 1994
1995:2 Gallringsundersökning 92
1995:3 Kontrolltaxering av nyckelbiotoper
1996:1 Skogsstyrelsens anslag för tillämpad skogsproduktionsforskning
1997:1 Naturskydd och naturhänsyn i skogen
1997:2 Skogsvårdsorganisationens årskonferens 1996
1998:1 Skogsvårdsorganisationens Utvärdering av Skogspolitiken
1998:2 Skogliga aktörer och den nya skogspolitiken
1998:3 Föryngringsavverkning och skogsbilvägar
1998:4 Miljöhänsyn vid föryngringsavverkning - Delresultat från Polytax
1998:5 Beståndsanläggning
1998:6 Naturskydd och miljöarbete
1998:7 Röjningsundersökning 1997
1998:8 Gallringsundersökning 1997
1998:9 Skadebilden beträffande fasta fornlämningar och övriga kulturmiljövärden
1998:10 Produktionskonsekvenser av den nya skogspolitiken
1998:11 SMILE - Uppföljning av sumpskogsskötsel
1998:12 Sköter vi ädellövskogen? - Ett projekt inom SMILE
1998:13 Riksdagens skogspolitiska intentioner. Om mål som uppdrag till en myndighet
1998:14 Swedish forest policy in an international perspective. (Utfört av FAO)
1998:15 Produktion eller miljö. (En mediaundersökning utförd av Göteborgs universitet)
1998:16 De trädbevuxna impedimentens betydelse som livsmiljöer för skogslevande växt- och djurarter
1998:17 Verksamhet inom Skogsvårdsorganisationen som kan utnyttjas i den nationella miljöövervakningen
1998:18 Auswertung der schwedischen Forstpolitik 1997
1998:19 Skogsvårdsorganisationens årskonferens 1998
1999:1 Nyckelbiotopsinventeringen 1993-1998. Slutrapport
1999:2 Nyckelbiotopsinventering inom större skogsbolag. En jämförelse mellan SVOs och bolagens inventeringsmetodik
1999:3 Sveriges sumpskogar. Resultat av sumpskogsinventeringen 1990-1998
2001:1 Skogsvårdsorganisationens Årskonferens 2000
2001:2 Rekommendationer vid uttag av skogsbränsle och kompensationsgödsling
2001:3 Kontrollinventering av nyckelbiotoper år 2000
2001:4 Åtgärder mot markförsurning och för ett uthålligt brukande av skogsmarken
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This report is the main publication from the Swedish component of the international EU/LIFE co-funded project “Demonstration of Methods to Monitor Sustainable Forestry”. The Swedish project was a joint effort between the National Board of Forestry and the Swedish Environmental Protection Agency. In all, the project had seven partners in five European countries.

Data from Swedish monitoring systems are compared to the data requirement of the quantitative indicators on sustainable forestry adopted by the Ministerial Conference on the Protection of Forests in Europe. Also the indicators are scrutinised. Suggestions on new indicators or modifications of existing definitions are presented. In some areas where a lack of information is identified, the project has demonstrated monitoring methods to cover the needs. The demonstration effort was carried out in two demonstration areas in Uppland and Norrbotten.

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