A time study and description of the work methods for the field work in the National Inventory of Landscapes in Sweden

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Arbetsrapport 140 2005

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ISSN 1401-1204
ISRN SLU-SRG--AR--140--SE

PREFACE

This study was encouraged by the National Inventory of Landscapes in Sweden (NILS), in their interest of finding the tools to optimize the organization during the field season and to find the most effective working methods for the fieldwork. NILS and the Department of Forest Resource Management and Geomatics at the Swedish University of Agricultural Sciences in Umeå have provided personal, technical and economical support to this investigation, in cooperation with the Division of Forest Technology of the Department of Silviculture at SLU. The cooperation and the enthusiasm of the field teams working for NILS was an exceptional help for this investigation due to the difficulties to investigate the specific tasks of the fieldwork in situ.

ABSTRACT

A TIME STUDY AND DESCRIPTION OF THE WORK METHODS FOR THE FIELD WORK IN THE NATIONAL INVENTORY OF LANDSCAPES IN SWEDEN

Fieldwork is an essential part of forest or environmental inventories and has one of the biggest parts of the budget, but the way in which the resources are distributed is usually unknown. The use of a time study of the inventory fieldwork seems to be a good approach to understand the way the resources are distributed. Time studies have already been used for many years in the industry and in the forest sector in order to analyze and optimize the working methods.

This study applies this methodology to study fieldwork of the National Inventory of Landscapes in Sweden, (NILS) during the season 2004. NILS survey the biological diversity, its factors and other cultural and recreational values from a national perspective and study its changes over time. Fieldwork is done by teams of two persons distributed along the whole of Sweden and includes transportation, field inventory and administrative work.

Each team spend an average of two hours and 25 minutes travelling to the location of the area of study every working day, in addition they have to walk an average of 16 minutes. The field inventory is divided into plots and lines. The average time per each plot done by two persons is 34 minutes. The average time per each line done by two persons is 18 minutes. The average time spend by a team in the administrative work is 42 minutes every day. The estimation of the cost of each plot is 1592 SEK and each line 859 SEK. There are 7572 plots and lines distributed in to 631 landscape areas to be inventoried one fifth every year in a cycle of five years.

The main factors that influence the consumed time considered in this study are: Area, number of divisions of the plot, number of intersections found in the line and presence of obstacles that makes the plot or parts of the line inaccessible. There are some other factors that should be analyzed in future studies by comparison of the time consumed and the data obtained in the inventory. The working method used by the different teams was very similar with only a few differences often due to the differences between the areas. There is a great potential to continue this line of investigation within inventories since there is not much done in this direction.

A TIME STUDY AND DESCRIPTION OF THE WORK METHODS FOR THE FIELD WORK IN THE NATIONAL INVENTORY OF LANDSCAPES IN SWEDEN

INTRODUCTION

In many researches and studies, the fieldwork has one of the biggest parts of the budget. Forest or environmental inventories are not an exception and even with the advantages of the use of remote sensing, the fieldwork keeps being an essential and unavoidable part of the work. The evaluation of an inventory is usually done, first knowing if the desired information is actually collected and if the cost is within the limits of the budget. So it would work as a black box where you introduce a certain amount of resources and you get the information needed as output, but the way in which the resources are distributed is commonly an incognita. The use of a time study of the inventory fieldwork seems to be a good approach to understand the way the resources are distributed inside this black box. Time studies have already been used for many years now in the industry with excellent results, being an indispensable tool for planning any process. Within the forest sector, time studies are largely used in productivity analyses, for instance in harvesting machines and harvesting methods.

This study is based on the fieldwork of the National Inventory of Landscapes in Sweden, (NILS) which commenced in full scale during 2003. When the inventory is new, the information of how the resources are distributed within the inventory is specially needed, to be able to add, remove or adjust the elements within it according to the true needs.

1.1 <u>Time study and work measurement review</u>

According to Barnes (1968), time study is defined as the analysis of the methods, of the material, and of the tools and equipment used, or to be used, in the performance of a piece of work in order to:

- Finding the most economical way of doing this work
- Standardizing the methods, materials, tools and equipment
- Accurately determining the time required to do the task
- Assisting in training the worker in the new method

There are two different types of time studies, correlation studies and comparative studies. Correlation studies are done to establish relationships between the time consumption for the work task and the factors influencing the work. Comparative studies compare the time consumption or productivity for different equipments or work methods used to perform the same work task. They are usually done to evaluate the performance of new equipment or work methods compared to the prevailing way to do the work.

The result of a time study is the time in minutes that a person suited to do the job and trained in the specified method, will need to perform the job if he works at a normal or standard tempo.

The work is divided into work elements for a number of reasons: ((Anon.1978) work element is a clearly defined part of the work)

- To reduce the number of influencing factors. A work element is often influenced by a few factors while the total time is influenced by many. If the division in work elements is detailed enough the work element might only be affected by a single factor or correspond to a constant time

- Furthermore, an influencing factor or a treatment might influence two work elements but in different directions so that the effect on the total time consumption disappears
- The variance is often smaller for the time consumption of a work element than for the total time consumption, and this makes it easier to detect treatments differences

Time measurements are done using either directs or indirect methods. In direct timing the time for each work element is measured with a stopwatch or a handheld computer. During work samplings the study man observes what work element the machine or worker is doing at specific points of time. These points are separated by either a random or a fixed time interval. The large advantages with work sampling are that elements of short duration can be suited and that one study man can study more than one worker or machine. However work samplings are not so easy to use when correlation between an influencing factor and a work element is of interest.

1.2 Description of NILS

NILS aims to survey the biological diversity from a national perspective and to study its changes over time. The inventory is primary concentrated in the conditions for biological diversity and the factors that influence this but also other aspects of cultural and recreational values. Special focus is placed on condition and changes in land use and land cover as well as the aerials of different types of nature and their distribution in the landscape. NILS is a part of the national environmental supervision conducted by The National Environment Protection Board (Naturvårdsverket) and is a part of the program sub division Landscape (Landskap). NILS includes all land environments in Sweden, agricultural domains, wetlands, lands with constructions, forestlands and mountains. The results from NILS are used in the follow up of national environmental goals and also in the follow up of some parts of “Natura 2000 habitat”. (Esseen et al. 2004).

The Department of Forest Resource Management and Geomatics of SLU (Swedish University of Agricultural Sciences) in Umeå conducts NILS, with cooperation from SLU in Uppsala, Umeå University, and other external experts when needed. The fieldwork is done by personnel hired for the field season.

NILS is based on a combination of interpretation of aerial photographs and field inventories. The interpretation of the aerial photos is done in infrared aerial photos that are scaled 1:30000. Through the interpretation, partly a rough picture of the whole sample plot area is received partly scattered data for formal estimations of stock and changes where also field data are included. A lot of estimations are based on a combination of data from aerial photos and field data, through a so-called two-phase estimation. In this way NILS is not dependent of having the same kind of air photo estimation all the way through the program. If new and more effective methods of remote sensing are developed, these can replace the methods in use now. This is based on the similar way of collecting the field data during the whole program. (Esseen et al. 2004).

NILS consists of the following parts (see Figure 1.1):

- Overview photo interpretation within a square area of 5x5 km (“The landscape area”).
- Detailed photo interpretation of the central 1x1 km. square area, of the object surface (protraction of the whole cover, categories of land covers, detailed classes), line objects and dot objects

- Field inventory within a square area of 1x1 km. The following segments are included:

    1. Inventory of a circular sample plot, where land cover, land use, measures, soil and vegetation all are thoroughly described
    2. Inventory of line crossings of linear objects (2,4 km length of lines)
        - Streams, ditches, roads, stonewalls forest edges etc.
        - Linear land interruptions (tracks from vehicles, reindeer tracks, woodland paths etc.)

1.2.1 Overview over elements included in NILS

The interpretation of the air photographs are done through delimiting homogenous polygons, from which the contents later on is being interpreted after a predetermined pattern, that will be the basis for classifying the nature types and area calculations. The objects seen in the aerial photos but which are too narrow or have too small areas to delimit are described as linear objects. (Allard et al. 2003).

The inventory in field will be connected with the interpretation of the aerial photos as much as possible, through determination of the position of the described sample plot and objects in relation to the interpreted areas and objects. In addition, as much as possible the same types of variables and definitions are used. In field, a large number of variables are being registered which are impossible to register when interpreting aerial photographs. The information from the inventory in field is collected in a fixed grid that consists of permanent sample plots and of linear objects collected in the line inventory (Figure 1.1).

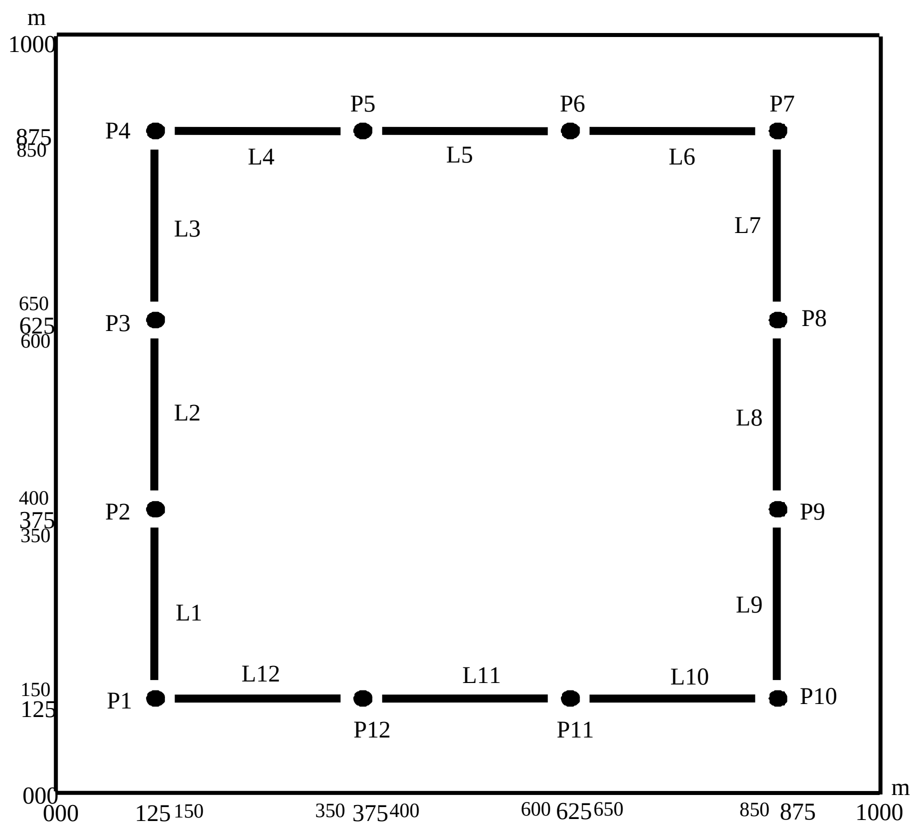


Fig. 1.1 shows the central 1x1 km area with the disposition of the 12 circular sample plots and 12 lines (Source NILS)

The sample plots are the foundation for calculations of diversity, condition and changes for area covering nature types. From these, systematic samples of the whole land area of Sweden are received. The size of the sample plots almost coincide with the smallest protraction unit in the aerial photo interpretation, this means that you get comparable "area resolution" from the data collected. If there is a clear border in difference of land use or land cover through the plot (and all the sections are part of a bigger, uniform area) the plot will be divided and the sections will be described separately. As the interpretation of the air photos this sample plot inventory also consists of a number of homogenous spots ("patches"), which are separately described if they are minimum 0,1ha, or at least 0, 05 ha if the land use and land cover at the same time differ from the conditions of the surroundings. (Allard et al. 2003).

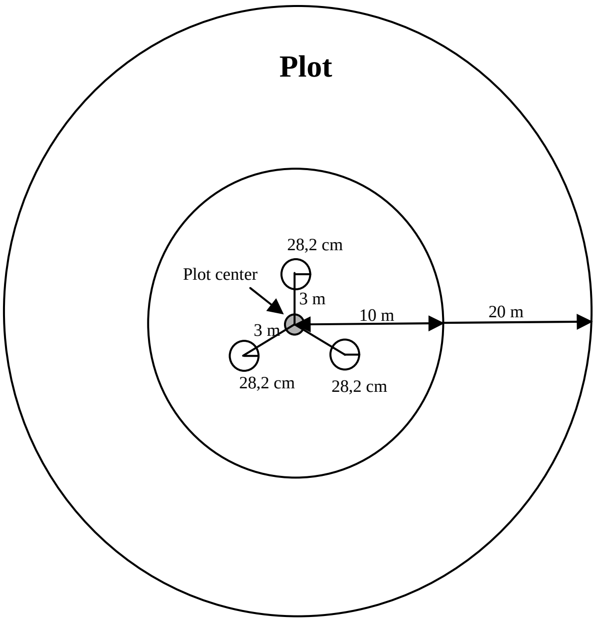


Fig. 1.2 shows the disposition of the big sample plot and the three small sample plots

From the line-inventory you get a random sample of a number of pre-defined types of line objects, that in total are covering a relatively small area, and you don't capture these in a good way through the fixed sample plots. Of practical reasons these objects are not permanently marked in the same way as the sample plots, but you register the objects that are found along the line and the belt. This way of handling the random samples helps to estimate quantity of these objects in the entire landscape efficiently and easy. Many variables are the same as for the sample plots, which makes it easy to compare nature types etc., whereas others are more specific for each kind of object.

Table 1.1 some of the NILS inventory elements measured on the different sizes circular sample plots

20m	10m	0,28m
Main type of ground cover Ground covering trees Land use Measures/ influences Nature type/ high mountain	Ground covering bushes Ground covering field layer Ground covering ground/bottom layer Description of the land/ ground Detailed tree data * (Even 3,5m radius) *Lung/skovellav*	Field layer Ground/ bottom layer Occurrence of vascular plants Occurrence of mosses Occurrence of lichens Occurrence of manures

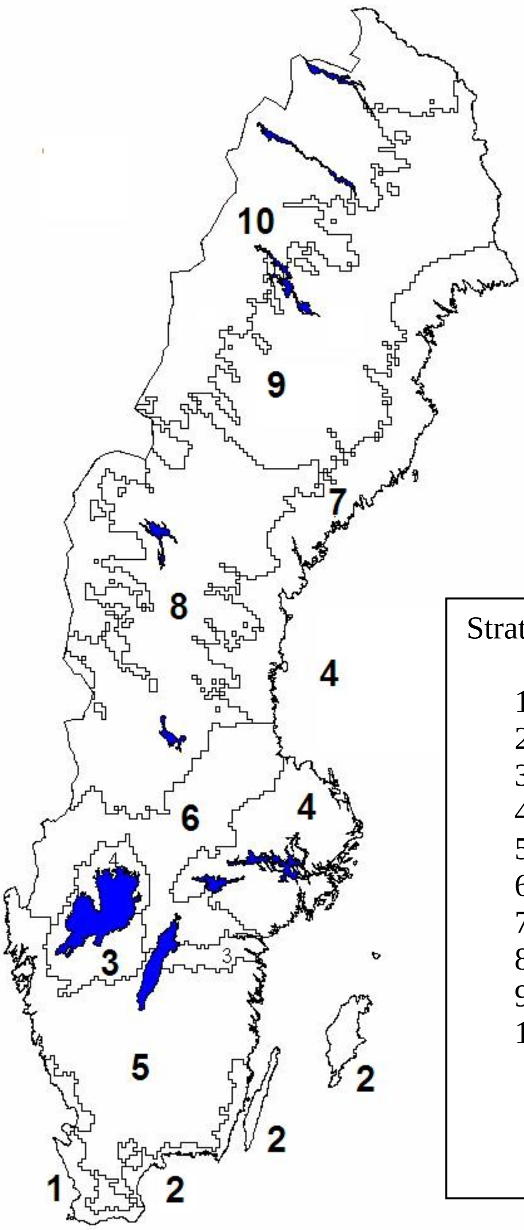
* Only done on sample plots that are not considered forestland according to FAO's definition, on high mountain birch forest and on discontinued agricultural land.

The inventory of the 12 systematically placed sample plots are done according to table 1.1. Each plot consists of concentric circular sample plots with radius of 10 and 20 meters. In addition to this there are 3 small sample plots (0, 25 m^2) for supervising the vegetation

1.2.2 Outlay of NILS landscape areas

Strata

To be able to disperse the systematic sample areas it was necessary to divide Sweden into geographical strata. This is partly to be able to disperse the areas with different densities in different parts of Sweden, but also to be able to adjust the content of the inventory to special conditions in different parts of Sweden. In the South and the middle part of Sweden, the division into strata is based on the eight production areas that The Swedish Board of Agriculture is working with. This means that the production areas 1-6 form strata 1-6 in NILS.



Strata:

1. Götland south plain district
2. Götland middle district
3. Götland north plain district
4. Svealand plain district
5. Götland forest district
6. Middle Sweden forest district
7. Norrland coast land
8. South Norrland inland
9. North Norrland inland
10. Mountain and mountain forest

Fig. 1.3 division of Sweden into 10 geographical strata (Source NILS)

In the Northern part of Sweden the high mountains and their nearby forests has their own strata that consists with Swedish Environmental Protection Agency's border for nature conservation. The coast of Norrland is separated in its own strata based on the high coastline (HK). This is to try to include agricultural land in Norrland

The high coastline follows more or less the occurrence of agricultural land, but in some cases it goes far into the inland. Therefore the border for this stratum has been modified on some shorter distances where HK went too far into the interior parts. The inland of Norrland was later parted into two strata based on the border in between Jämtland/ Ångermanland and Västerbotten. In total there are 10 geographical strata in NILS (see Figure 1.3). (Ringvall et al. 2004).

1.2.3 NILS Landscape areas

NILS Landscape areas are localized together with the inventory routs of the nesting birds, which are dispersed systematically in a pattern with constant density all over Sweden. Whole Sweden has been divided in 5*5 km square areas that don't overlap each other. The division is done in the economical map. The stratum that one area belongs to is decided by in which stratum the biggest part of the 1*1 km area in the middle of the bigger area is (in the centre of the 5*5 km square area). The dispersion of the areas is condensed in some strata and sparse in others in comparison with the nesting bird's inventory (table 1.2). The compacting and thinning of the inventory of nesting birds' routs were done in a systematically made pattern with a drawn first point.

The total number of areas as well as the dispersion of the strata has been done among other things with the background of studies concerning the strength that type variables in estimations of changes have. This means a compacting in dispersion in the strata 1-3 and a thinning in the strata 6-9 (Table 1.2). In total there are 631 landscape areas in NILS, which are numbered from the south to the north. Every year one fifth of the areas distributed all along Sweden are inventoried. In NILS all areas are included if there are any land area within the 5*5 km square area according to the blue map. For practical reasons areas with too little land area are not being photographed from the air. Areas along the coast are not being photographed if less than 5% of the 5*5 km square area is land at the same time as th *1 km square (<1 ha) is totally without land. Areas adjacent to Norway are not being photographed if less than 15% of the area is covered by Swedish territory. The number of areas affected in every stratum is clearly seen in table 1.2.
(Ringvall et al. 2004).

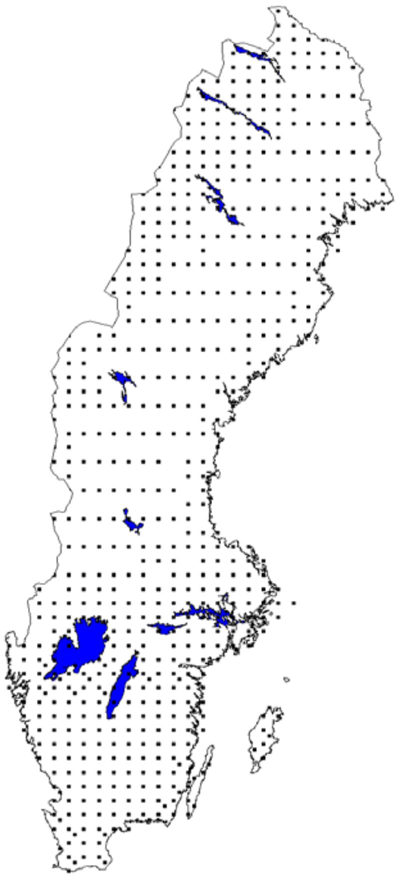


Figure 1.4 Localization of NILS random sample areas (source NILS)

Table 1.2. Number of random sample areas in NILS as well as compacting/thinning compared to the inventory of nesting birds

Stratum	Compacting/ thinning	Number of NILS-Areas	Without air photo	No field inventory [1]
1	150 %	13	1	2
2	150 %	37	1	5
3	150 %	33	3	3
4	100 %	63	3	5
5	100 %	99	3	5
6	80 %	52	1	3
7	80 %	60	5	8
8	50 %	66	1	2
9	50 %	64	-	-
10	100 %	144	7	15
Total		**631**	**25**	**48**

[1]Squares without land within the 1*1 km area

1.3 NILS field work

The fieldwork is done by a total of seven teams with two persons in each. The teams are distributed all around Sweden. To reach the study areas and to transport all the equipment the teams usually use cars. Sometimes the study areas are remote and inaccessible by car, and other methods of transportation are used, for example helicopter or boat. The teams need to find accommodation in the surrounding of the areas, and drive there every day. The commuting time is included in the working time. The field data is collected with help of an "allegro" handheld computer per surveyor using a program specifically designed for the NILS field work. It is needed to download and save the information on a daily basis and deliver a compact disc copy at the end of each area. They have a working day of ten hours in order to use the day better, since they have to travel quite a lot. This also permits them to have more days free.

Description of the fieldwork:

The main work moments for the fieldwork are:

Transportation
Field inventory
- Plots
- Lines

Data saving and administrative work

1.3.1 Transportation

Transportation includes the time the teams spend from starting in the morning by loading the car with all the field equipment and driving as close to the area as possible. Sometimes it's also needed to walk from the car to the point where they can start the data collection. We count also all the way back form the area of work to the place where the team has the accommodation.

1.3.2 Field inventory

The field inventory can be divided into two parts: plots and lines. Each one had been also divided into work elements. Each work element is composed by a task or a group of tasks that are related and will be considered in this study as a unit.

1.3.2.a Inventory of the plots

The different work elements in the plots can be done individually or as a team. The most elements are divided for individual work and only the first tasks in the plot are done as a team. The division of the tasks within the team don't differ much from one team to the others so a common method is going to be describe and differences in the team's performance will be noticed later on. Since many work elements are done individually and in a particular order two roles will be stabilised. The persons in the team will be identified as Surveyor A and surveyor B according to which part of the work they are doing. The role surveyor A or B is in general switched between the workers every second plot, but that can change depending on the work element and the team.

The beginning of the work in the plot is finding the central point; they work together for this and for a part of the task called"Start". After this the division of the tasks is well defined. The surveyor A start with the task "Ground cover in the big sample plot" while surveyor B is finishing alone the task "Start". Then surveyor A continue with: "Bushes in the big sample plot", "Land use", "Measure Influence", "Soil description", "Slope", "Lichen", "Mountain forest species" and "Natura 2000". In the meanwhile surveyor B is doing the following tasks: "Photo documentation", "Estimation of coverage in the small sample plot" and "Present or absent species in the small sample plot". The task "Detailed measurement of trees" is usually done together but can be done individually if surveyor B is still occupied when surveyor A have finished all the other tasks. But this task is only done on sample plots that are not considered forestland according to FAO's definition, on high mountain birch forest and on discontinued agricultural land.

When division occurs they do the task so-called "division" together, on the other hand in this case all the tasks for surveyor A have to be done in every part in which the plot had been divided. In that case they start working as usual but when surveyor B is done they distribute the rest of the tasks in their own way.

In most of the cases, even without division, surveyor B finish before surveyor A so then he help with the tasks or parts of the tasks left from surveyor A, they usually divide the remaining tasks depending on the each particular situation.

1.3.2.b Inventory of the lines

When working in the line, the surveyors are performing as a team. One person is walking in front, navigating with the compass. The person in the back is standing still waiting, holding the end of a 50-meter long line to stretch out the line to measure this distance. The team repeat this for four times to cover 200 metres with the same line. The person in front marks out every 50 meter with a stick. He can wait until the person in the back arrive or continue walking if there are not so many intersections. When coming to an intersection the person in the front marks the 50 meters and then can go back to help the other one to register the measurements of the intersection

1.3.3 Administrative work

Every day during the evenings the teams download the data they have collected during the day to a laptop and then burn a compact disk containing this information. The data is downloaded from the handheld computer, the GPS and the digital camera. In addition the pictures from the digital camera should be checked in the laptop to make sure that there is not anyone missing or any unclear images. Every time that the team reach a new area they need to delete the waypoints from the last area in the GPS and upload the waypoints for the new one. A compact disk with all the information is sent to the office in SLU, Umeå when each area is finished.

Other activities that can be included in this part are reading e-mail from the office or the other teams and looking for accommodation or other special needs like means of transport.

1.4 Goals for the study

This work started as a desire from the NILS program to better understand the fieldwork, the distribution of the resources and to find the tools for better management and planning of the field season.

The objective of the study was to:

- Measure the time for the different parts, so called work elements, of the inventory for this study
- Find differences between different areas or environments
- Find different working methods and their influence of the work
- Find relationships between time consumption and the factors affecting it
- Evaluate economically the different tasks or measurements done in the field inventory

This report has the following main parts: the summary of the time consumed for the different parts of the fieldwork, a statistical analyze including some linear regressions and an estimation of the price or value for each part of the work. This is distributed along the main sections of the report introduction, material and methods, results and discussion.

The study performed in NILS is basically a correlation study. Though, when the work methods differ, it can turn into a comparative study in order to find the most effective work method. Thus direct timing was chosen for this study.

MATERIAL AND METHODS

The work in the study could be divided into four parts; a pilot study, the actual time study the statistical analysis and the price estimation. The pilot study was made in order to find the natural division of the field inventory into work elements. The time study include measure of time of the whole fieldwork; transportation, field inventory and data saving and administrative work. The statistical analysis aims to find significant differences between areas, and the influence of some factors. The Price estimation aims to evaluate the cost of the different parts of the field inventory.

2.1 <u>The pilot study</u>:

In order to study each element separately the NILS field inventory was divided into different elements. This was done by at the beginning of the season following a team in the south of Sweden for four days. The work in the plots was divided in 22 elements and the work in the lines was divided in 11 elements that are described below.

2.1.1 The work elements of the plot:

1) **Walk and navigate (Walk):** Navigate to the central point using GPS or using compass and distance.
2) **Start:** Register the central point. Nail down an aluminium profile, mark, measure and register some fix points. Mark the three small sample plots. Register important data in the plot, like dead trees and big rocks within the plot, also initiating the NILS program in the computer to be prepared to start registrations.
3) **Division of the plot (Division):** Decide if it should be divided, measure the limits of the divisions, fill out the division form.
4) **Ground cover in the big sample plot (Big ground):** Define the main land cover. Separate water and land environments. After this, classify the land-vegetation land cover (as terrestrial/ semi aquatic), substrates and bottom cover OR herbal cover within the 10m surface. Decide if it is an area permanently covered with water, OR exposed rock, OR without living things or only covered by a thin layer of lichen (skorplav); Exposed mineral soil without humus layer; Exposed humus or peat
5) **Bushes in the big sample plot (Big bushes):** Species and groups of species within the 10 m area (or part areas), Estimate the total cover of living bushes, Register the bush species
6) **Big sample plot forest and trees (Big forest):** Estimate tree variables within the 20m area (or part areas):
   Estimate how much area covered by trees
   Ground area
   Number of trunks
   Height
   Mixture of species
7) **Land use in the big sample plot (Land use):** Define the main conditions of the place and the land use.
8) **Measure influence (Influence):** Actions held in the area that determine the evolution of the ecosystem, estimation of the actions made during the past five years.
9) **Soil description (Soil):** Register soil and ground variables, moisture, texture, structure, humus layer, amount of rock and stones, etc.
10) **Slope:** Measure the maximum slope in the plot and its direction.

11) **Detailed measurement of trees (Detailed tree):** Measure detailed data of trees in plots that are not considered forestland according to FAO's definition, on high mountain birch forest and on discontinued agricultural land.
12) **Lichen:** Register two different lichen, "lunglav" *Lobaria pulmonaria* and "skrovellav" *Lobaria scrobiculata* as important bio-indicators.
13) **Mountain forest types (Mountain types):** Enclose different areas that do **not** correspond to FAO or Swedish definition of forest into classes according with NILS or RIS definitions.
14) **Natura 2000:** Enclose different ecotypes according with the Natura 2000 definitions.
15) **Mountain species (Mountain sp.):** Register the presence or absence of a list of species characteristic for mountain areas. Estimate the cover in square meters within the 10 m radio.
16) **Photo documentation (Photo):** Take pictures in the directions north, west, south and east. (The directions are measured with a compass). Take pictures of the small plot located north of the central point.
17) **Estimation of coverage in the small sample plots (Small sp.):** Estimate and register the percent of occupation of gramineae, small wood plants, bushes, mosses and lichens within each of the three small sample plots.
18) **Present or absent species in the small sample plot (Small cover):** Check and register the presence or absence of certain plants included in the given lists, including gramineae, small wood plants, bushes, mosses and lichens within each of the three small sample plots.
19) **Other:** Any activity that is not included in the list but is a part of the work; this could include packing and moving between the different plots and lines, or any registration that is not possible to measure as a separate task (going through the different menus, save a backup copy…)
20) **Assistance:** Consultations of any kind within the team, in order to clarify or ensure any matter, this also includes getting a common view for estimations later on.
21) **Waiting:** One person of the team some times has to wait, when the activities are such that there is no possibility to do any task until the other person in the team has finished what he/she is doing.
22) **Delay:** Non-productive time, including personal delays, private phone calls, lunchtime or resting time. This time was measured but not included in the study.

2.1.2 The work elements of the line:

1) **Walk and navigate:** Walk from the central point of the previous plot to find the starting point of the line using compass and distance.

2) **Establish and register the starting point (start):** Find the starting point of the line, register the point with the GPS and start the line in the handheld computer.

3) **Wait:** Wait in any of the four parts of the line since the person in front is walking with the compass.

4) **Walk:** Walk the line following the path that the person in front has given until an intersection comes up.

5) **Register intersection (intersection):** measure and introduce in the handheld computer the information for each type of intersection. The intersections are:

1. Transport lines
2. Vegetation stripes
3. Forest border
4. Fences
5. Water flows
6. Shore (when it is too wide to be included in water flows)
7. Forest and mountain hen
8. Fail (check if an intersection that don't fill the requirements do it or not)

6) **Register end of the line (end line):** when the whole line had been walked, register its ending point and finish the menus in the handheld computer for the line.

7) **Register Stop (stop line):** when an obstacle happen is needed to register the point where the line crosses it and which type of obstacle it is.

8) **Walk around the obstacle (obstacle):** when there is an obstacle in the line that is not possible to cross, that could be natural as a lake or a private zone like a house, a garden or crops. Then the team need to walk around this obstacle until the line gets out of the obstacle.

9) **Re-start line:** find and register the re-starting point of the line, the point where the line gets out of an obstacle.

10) **Delay:** Non-productive time, including personal delays, private phone calls, lunchtime or resting time. This time was measured but not included in the study.

11) **Other:** Any activity that is not included in the list but is a part of the work

2.2 Time study

2.2.1 Areas included in the study

After the division in work elements six different study areas were studied, figure 2.1. The locations of the areas were chosen in order to find information about the main landscapes in Sweden.

In the mountains, two areas were studied; Areas 602 and 585. Area 602 is located in the northwest part of Stora Sjöfallet National Park in Norrbotten County, not far from the Norwegian border and about 1300 meters of altitude, close to the top of Marko. Due to the high altitude the vegetation is not very abundant and it only grows close to the ground. The terrain is rocky and there is some slope. The area is covered with many small lakes and creeks. This area had many spots covered by snow even though it was in the middle of august. The location was remote so it was necessary to go there by helicopter and camp there for two nights. The weather was cold and windy but it didn't rain during the time of the study.

Area 585 is located in the northeast out border of Stora Sjöfallet National Park, in a transition zone, from plain terrain dominated with bogs and wetlands, with some spots of forest, to the drier slope of a mountain where forest covers the ground. Because of the non-existence of roads in the area it was necessary to travel by helicopter and camp there for one night.

During the time of work in those two areas some of the work routines changed, especially in reference with downloading the collected information and the administrative tasks, since the lack of facilities when camping. The days in between those areas were spent in a cabin so this was the time to do all those tasks you couldn't do the days before.

Area 462 was located at about 25 km southeast of Storuman in Västerbotten County. This area is included in the strata 9, North Norrland inland, according to the division used by NILS. The landscape is exploitation of forest with different ages, some clear-cut zones from a few years ago where dense springs where founded. This area is not far from a village, a road and the railway. Within the area there were some skiing and snowmobiles paths. The rain was persistent during the time of this study and also during the previous days of work for the team, the ground was more soaked than usually.

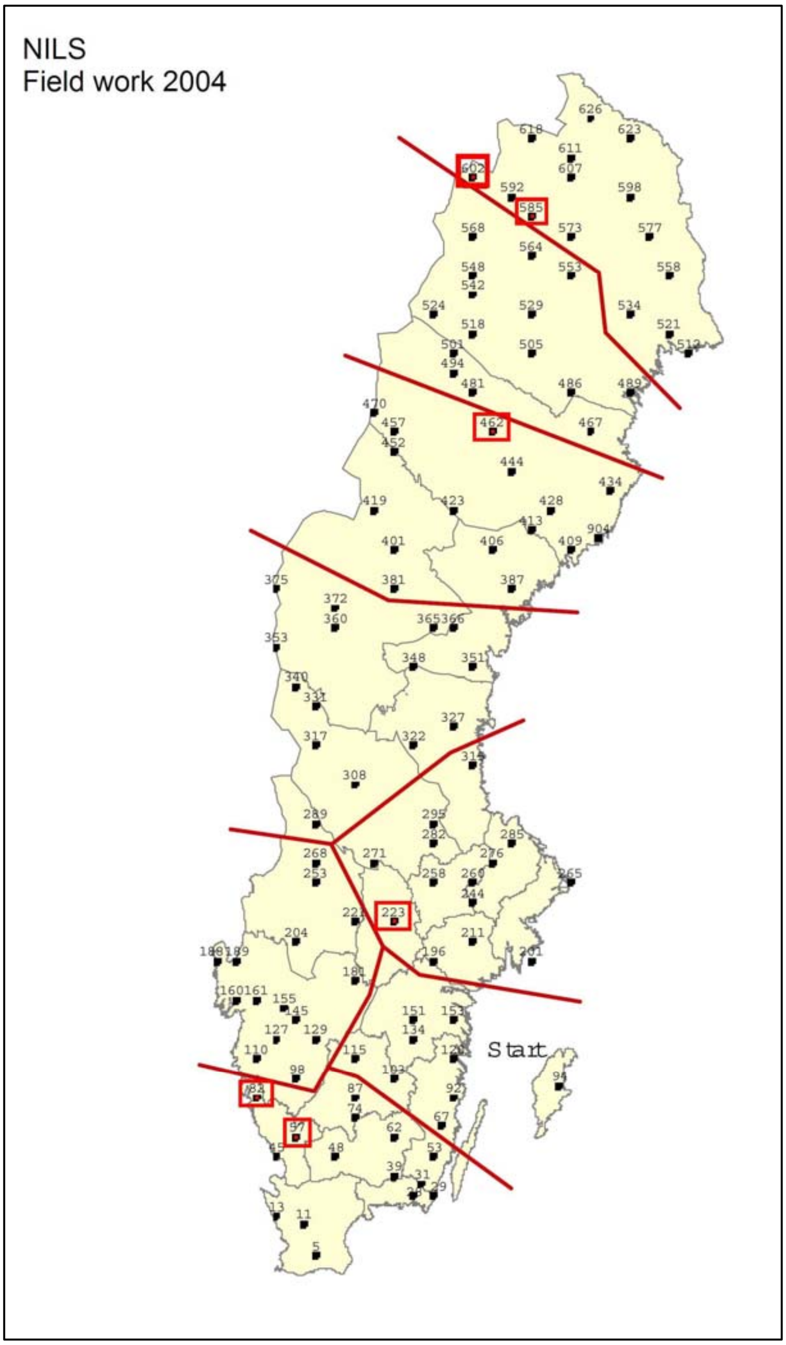


Figure 2.1: Areas inventoried in 2004 by NILS. The six areas marked with squares are the ones studied here.

Area 223 is located at about 30 km north of Örebro in Strata 4, Svealands plain district, according to the division used by NILS. The landscape is forestland mixed with some agricultural land, but the data collected from this area correspond mainly to the forest part of it.

Area 57 is located some kilometres northeast of Halmstad in Hallands County. This is included in Strata 5, Götlands forest district, according to the division used by NILS.

Area 82 is located about 20 km south of Göteborg in Strata 1, Götlands south plain district, according to the division used by NILS. The landscape in this area is dominated by agricultural land, but we can find some remaining forest. The plots and lines in studied in this area were those in the agriculture land, so many of the plots were inaccessible because they were in the middle of crops. Thus there is a lack of data about plots and the lines are often only a part of them or are even reduced to an intersection with a road or a creek.

2.2.2 Description of the time study

The time study was done by following four different teams in six different areas, (see table 2.1 and figure 1.5). Each team was followed during three or of four days, and the time for their fieldwork, transportation, field inventory and administrative tasks, were counted. In many cases the study implied spending 24 hours a day with the teams to get an accurate idea of the work distribution, since some tasks could be done during the evenings.

Table 2.1 teams and areas studied.

Area 602	Area 585	Area 462	Area 223	Area 82	Area 57
Team 1	Team 1	Team 2	Team 3	Team 4	Team 4

The study in each area consisted in measure the time that a surveyor need for each of the work element with the help of a handheld computer. A stopwatch and a form were used in some occasions due the failure or the lack of memory of the handheld computer. As well as a diary with the main conditions of the work and some other notes were written in every area.

The transportation time was measured, registering separately the time from the over night place to the working area and the walking time inside the area to the first plot or line.

Different studies were done for plots and lines. The time study in the plots were based on the division of the work that the team do; surveyor A and B. In that case each surveyor were followed separately in their tasks alternatively, and also switching the person that was doing it. Each person was followed during two half days and participating equally in both roles A and B. In addition every team was video taped in two plots in order to have some documentation and provide material that help after words to understand the working method and the division of the tasks between surveyors in each team. The time study in the lines was done in the basis of teamwork. The team was followed as a whole walking beside the person that was in the back so it was easier to notice the time for the intersections.

It was also registered the work done during the evenings, consisting in downloading and saving the data collected during the day as well as other logistic activities.

The data was collected using a handheld computer Husky hunter 16 and the software siwork3 designed by the Danish Forest and Landscape Institute (Rolew 1988). The handheld computer had to be set up for this study introducing the different work elements in the program, then a test was performance with a team in Norrland to be sure that the software and the actual division on work elements fits the real work.

In addition two plots of each area were video taped as documentation.

The time study was made during July and august 2004, which means from the middle to the end of the field season in the NILS project. Since some changes were made from the previous season it was necessary to give the teams some time to get familiar with the new parts of the work.

The people working in the field teams had generally a biology education background, with knowledge of forestry and experience in fieldwork. The teams are composed by two persons who have complementary skills and are able to perform well as a team. On the other hand every surveyor is competent for every task in the inventory so they can work with a new partner easily if necessary.

2.3 Description of the statistical analyses

The time for each work element was summarised by areas, the units used are centiminutes (1/100 minute).

Analysis of variance and a general factorial model in SPSS was used to detect the effect of the areas, for all work elements in the plots. No adjustments for multiple comparisons were done.

For the line elements, analysis of covariance was used to detect the effect of the number of intersections. In the cases the work element was affected, the means were corrected by the covariates that appear in the model of number of intersections.

Student's t-test was used to detect the differences between the areas. The result of the statistical analyses were considered significant if $p<0.05$. No adjustments for multiple comparisons were done. In the lines Student's t-test was used to detect the differences between the lines that start or end in the map because inaccessibility.

The total time for the lines and the time for the work element "intersection" present a linear relationship with the number of intersections in each line. A regression based on the analysis of the variance was performed in order to find the equations that link those times and the number of intersections.

2.4 Estimation of Price of the work elements

The fieldwork is characterised by a large amount of activities, and also a many different costs that are not clearly belong any work element. For this analyse the work elements from the field inventory are considered as the output and any other activity is just a complement necessary to get this target. The work elements are evaluated according to the percentage of time they take over the time for all work elements from plot and lines together.

The plots or the lines that were not accessible were also counted with a value equal to cero. So that the total number of plots and lines for the whole season can be used as it is, considering that the occurrence of non accessible plots or lines will be constant for the rest of the areas, and for following seasons.

The time measured for each work element in every area was added. Also the total time for every work element was obtained from all areas. By comparison of those figures the percentage of time that each work element takes over the total time was calculated.

The weight of each work element is based directly from its percentage over the total time consumed and assumed that the time expended in other tasks not directly in the field inventory is distributed proportionally to this weight.

The total cost of the fieldwork during the season 2004 was 3 352 000 Swedish krona. This figure includes the salary for the field teams, salary for other personal eventually hired meeting and formation of the teams at the beginning of the season, cost of transportation, compensation for working out of their home region, diverse material and overhead for the institution, faculty and central SLU. All the tables and figures are presented in Swedish krona.

The variable cost of the fieldwork during the season 2004 was 2 131 000 Swedish krona. This figure includes the salary for the field teams and overhead for the institution, faculty and central SLU.

The calculation of the cost of the areas is based on the fact that 114 areas were done during this season and not the theoretical number of areas 631 every 5 years.

The calculation of the cost for each plot or line is based on the fact that every area contains 12 plots and 12 lines.

RESULTS

The amount of data obtained in this study is quite abundant so it is presented in different parts. The main body of the study is composed by the results for the work elements in the plots and in the lines, including important information about the statistical analyse. A linear regression is also presented for the total time in the lines. At the end some estimations of the cost of each work element is included. See also appendix 1 with all the records.

3.1 Time study of the transportation

The time that the field teams spend travelling every day from the accommodation to the location of the area and back, have been measured and summarised. The average time is about two hours and 25 minutes per day. This time is expended mainly travelling by car but could also be by helicopter or boat.

The average walking time inside the area to the first plot or line and back to the car at the end of the day was almost 16 minutes.

In total, two hours and 41 minutes was spent every day on transportation by each team as an average.

The time for travelling home every second week is not included, but it is included in the total cost.

Table 3.1 Average of transportation time spent every day for each team expressed in minutes.

Task	car	walk	total
Average time	145	16	161

3.2 Time study of the field inventory

The majority of the data is about the field inventory and here it is presented separately in plots and lines.

3.2.1 Time study of the plots

The results for the plots has been summarized presenting the statistical analyse first and then the mean values obtained from them divided in the role of surveyor A and B for each area and each work element.

The average time consumed for each plot done by two surveyors including plots with and without division but not the plots not done because they were not accessible is almost **38 minutes**. This is the average of the plots actually done.

The average time consumed for each plot done by two surveyors including plots with and without division and also every plot in the areas of study even thus they were not accessible is **34 minutes**. This is the average of the plots for the whole inventory assuming that occurrence of not accessible plots is constant.

3.2.1.a Statistical analyze

Table 3.2 shows the results of analyze of the variance obtained from SPSS for the total time of the plots. The adjusted R Squared of 0.611 means that the model explains over 61 percent of the data. On the other hand the value of the significance for the area is less than 0.05 that means that there is a statistically significant difference depending on the facto area

Table 3.2 plot ANOVA values

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.
Corrected Model	23357977,386a	5	4671595,477	13,236	0,000
Intercept	274452653	1	274452652,700	777,576	0,000
AREA	23357977	5	4671595,477	13,236	**0,000**
Error	12000616	34	352959,300		
Total	565226120	40			
Corrected Total	35358594	39			

a. R Squared =0,661 (Adjusted R Squared = 0,611)

The work elements in table 3.3 with a p-value less than 0.05 present a statistically significant difference in time between the different areas.

Table 3.3 shows the ANOVA p-values with a four degrees of freedom for surveyor A and five degrees of freedom for surveyor B. The cells without information shows that this work element is not done by this surveyor or that the distribution of work has been different and therefore it has not been possible to study it the same way. There are statistically significant differences in time consumed between areas is if p< 0,05

Work element	Surveyor A	Surveyor B
1) Walk	0,010	0,093
2) Start	0,295	0,157
3) Division	0,438	0,829
4) Big ground	0,032	
5) Big bushes	0,003	
6) Big forest	0,000	
7) Land use	0,187	0,100
8) Influence	0,040	0,255
9) Soil	0,011	0,059
10) Slope	0,067	0,356
11) Detailed tree	0,398	0,754
12) Lichen		
13) Mountain types	0,038	
14) Natura 2000	0,033	
15) Mountain sp.	0,227	
16) Photo		
17) Small sp.		0,036
18) Small cover		0,201
19) Others	0,095	0,012
20) Assistance	0,394	0,784
21) Wait	0,205	0,041

3.2.1.b Data presentation

This section presents the data obtained from the time study of each work element in the plots. The effect of the work distribution and the influence of the area will be showed.

The work in the plots can be done as a team or individually; table 3.4 shows the elements done by each surveyor. When there is time registered for one of the surveyors and nothing for the other, it means that the work was done individually. Work elements with time registered in both columns means that the element was done as a team. Occasionally help from the other surveyor can be observed by registration of time in both surveyors' columns, but in this case one of them has a much shorter time. There was no registration for the work element "lichen" during the time study. The work element "photo" is not equally done in every team so it was not possible to separate it for the two surveyors in this table.

Table 3.4 The average time in centiminutes per plot for each surveyor role, separated in work elements and areas. The divided plots have not been included in this table. (There are no registrations of surveyor A in area 82, empty spaces)

	Area	57	82	223	462	585	602	Notes
Start	Surveyor A	628		558	722	888	913	
	Surveyor B	1288	854	1678	1202	1257	1230	
Walk	Surveyor A	129		50	245	142	69	
	Surveyor B	112	85	129	248	88	113	
Division	Surveyor A	0		28	0	0	0	
	Surveyor B	0	0	0	28	0	40	
Big ground	Surveyor A	200		1229	375	666	530	
	Surveyor B	0	0	0	0	0	0	
Big bushes	Surveyor A	43		74	79	167	0	
	Surveyor B	0	0	0	0	0	0	
Big forest	Surveyor A	786		1399	968	604	0	
	Surveyor B	0	0	0	0	0	0	
Land use	Surveyor A	89		62	128	66	17	
	Surveyor B	0	0	0	19	0	0	
Influence	Surveyor A	21		284	59	18	15	
	Surveyor B	0	0	0	37	0	0	
Soil	Surveyor A	273		774	224	399	131	
	Surveyor B	0	0	0	122	0	0	
Slope	Surveyor A	40		108	84	42	130	
	Surveyor B	0	0	0	16	0	0	
Detailed tree	Surveyor A	0		0	0	309	0	
	Surveyor B	0	0	0	0	204	0	
Lichen								No register
Mountain types	Surveyor A	0		0	0	64	25	
	Surveyor B	0	0	0	0	0	0	
Natura 2000	Surveyor A	0		0	0	70	464	
	Surveyor B	0	0	0	0	0	0	
Mountain sp.	Surveyor A	0		0	0	0	45	
	Surveyor B	0	0	0	0	0	0	
Photo		150	298	307	205	385	578	Different methods
Small sp.	Surveyor A	0		0	0	0	0	
	Surveyor B	555	585	746	332	913	188	
Small cover	Surveyor A	0		0	0	0	0	
	Surveyor B	689	700	1194	456	863	358	
Others	Surveyor A	172		372	609	280	307	
	Surveyor B	269	802	446	326	486	173	
Assistance	Surveyor A	4		68	20	6	115	
	Surveyor B	114	48	122	6	22	218	
Wait	Surveyor A	0		279	6	0	364	
	Surveyor B	0	0	342	57	0	28	

The mean values of the time spent in each area for all the work elements and the total of the plot is presented in the table 3.5. It is possible to see the amount of time spent in each work element and compare it between the different areas. Table 3.3 shows if there are significant differences.

Table 3.5 the total time used in the plots per work element for the whole team separated in areas. The plots with divisions have not been included in this table; therefore differences between areas can be observed. The average time for each surveyor has been added so the time obtained is centiminutes/person for each plot. Total time exposed in the last row is the time spent by the team; consequently the units are centiminutes/2 persons for each plot. (There are no registrations of surveyor A in area 82, empty spaces)

Work element	Area 57	Area 82	Area 223	Area 462	Area 585	Area 602	Mean
1) Walk	241	85	180	494	230	183	235
2) Start	1916	854	2236	1925	2146	2144	1870
3) Division	729	620	425	142	0	541	491
4) Big ground	201		1229	375	667	531	600
5) Big bushes	44		75	80	168	0	73
6) Big forest	787		1400	968	604	0	752
7) Land use	90		63	148	67	17	77
8) Influence	22		285	97	18	16	87
9) Soil	273		774	346	399	131	385
10) Slope	41		109	100	42	130	84
11) Detailed tree	0		0	0	514	0	514
12) Lichen	0	0	0	0	0	0	0
13) Mountain types	0		0	0	65	25	45
14) Natura 2000	0		0	0	71	465	268
15) Mountain sp.	0		0	0	0	46	46
16) Photo	150	298	307	205	385	578	321
17) Small sp.	556	585	746	332	914	188	553
18) Small cover	689	700	1195	457	863	359	710
19) Others	441	802	819	936	767	481	708
20) Assistance	118	48	191	27	29	334	124
21) Wait	0	0	622	63	0	392	359
TOTAL	**2747**	**3492**	**5099**	**3290**	**3864**	**3015**	**3584**

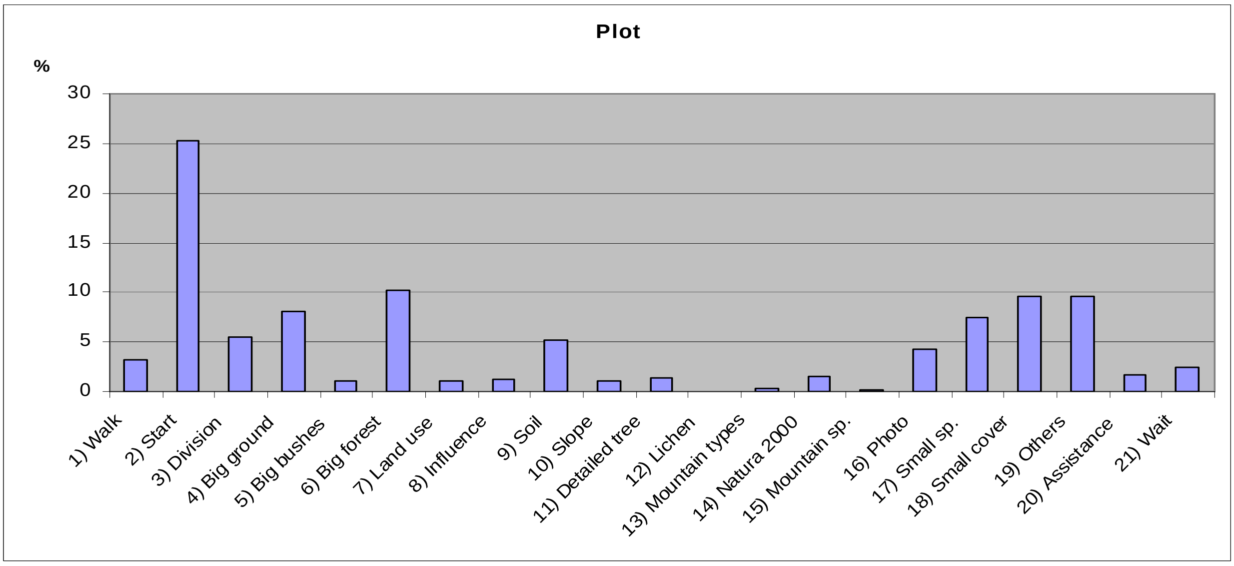


Fig. 3.1 mean time consumed by the different work elements of the plot expressed as percent of the sum of all elements.

Total time:
Area 223 has a significant difference with all the other areas, taking the longest time of all of them. Area 585 is significantly different in time to every other area except for area 82. Areas 57, 82, 462 and 602 can be included in the same group since there is not a significant difference in time consuming between them.

1. **Walk & navigate (Walk):**

This work element is done as a team, since is needed to stretch the line to measure the distance. But some times one surveyor can start navigating while the other is doing other tasks. Area 462 presents a significant difference in time with the rest of the areas since it takes about the double time than the average. There are some differences between surveyors A and B but there should not be since is a teamwork.

2. **Start:**

This work element is partially done as a team and partially individually. Both surveyors start working together until a moment when surveyor B keeps working with this task and surveyor A works with the “ground cover in the big sample plot”. The shared part is not exactly the same for every team but the results are pretty similar in every area. The part done as a team presents not significant differences in time between the areas. The part done individually by surveyor B is also quite similar in time, area 223 is the slowest one presenting a significant difference in time with the fastest areas: areas 82 and 462.

3. **Division of the plot (Division):**

During the study, the Areas 57, 82, 223 and 602 had plots with divisions. Area 462 has a plot that was about to be divided but it was not divided in the end, thus the short time measured. The same problem occurs in other areas containing both plots divided and divisions that were not done at the end, which makes it difficult to compare the different areas. The values of the time observed are similar in every area and even more similar when only actually divided areas are counted (around seven minutes)
The division of the plot in area 602 doesn’t seem to affect to the total time consumed since in many cases this division was just between rocks and snow or water.

4. **Ground cover in the big sample plot (Big ground):**

The surveyor A in every area carries out this element, and it’s done individually. The surveyor walks around the centre of the plot trying to get a general impression of the plot from different levels of proximity. Registering data into the handheld computer he can notice and put more attention in some elements that will need to be registered later as lichens.
Area 223 appears to be slower than the others; it has a significant difference in time with areas 57,462 and 602. All areas except for area 223 can be grouped into the same group being the forest areas that are a little bit faster than the others.

5. **Bushes in the big sample plot (Big bushes):**

This element is surveyor A’s in every area, carried out mainly individually but with some few consults and assistance from the other surveyor.
Area 602 is above the altitude that makes growing and development of any kind of bushes possible, so we can’t find them here and the time spent in this task is none.
The area 585, located in the mountains, is significantly different in time from the others. It would be possible to find other areas with a higher presence of bushes in any location and where the time consumption would raise.

6. **Forest and trees in the big sample plot (Big forest):**

This element is for the surveyor A in every area to carry out mainly individually but consults and assistance from the other surveyor can be necessary.
Area 602 is located above the tree line; we cannot find any trees here, so the time consumption for this element is none.
Area 223 have a significant difference in time from all the others areas, being the largest one. Areas 462, 585 and 57 are pretty similar in time consumption without any differences for the different locations of the areas.

7. **Land use in the big sample plot (Land use):**

This task is carried out mainly by the surveyor A but sometimes surveyor B can join him in this task when his tasks are finished. This has been registered particularly in the area 462 but it can appear in anyone.
The time for this task is mainly very short; we just find a significant difference in time between areas 462 and 602.

8. **Measure influence (Influence):**

This task is carried out mainly by the surveyor A but sometimes surveyor B can join him in this task when he has finished his/hers tasks. This has been registered particularly in the area 462 but it can appear in anyone.
The time consumed for area 223 is almost three times longer than the following one that is area 462. In all the other areas the time consuming is less than one minute. In area 462 it takes longer than in areas 602, 585 and 57.

9. **Soil description (Soil):**

This task is for surveyor A, but it is common that surveyor B finishes his part first and helps. Area 462 takes more than double time than the average for the other areas. The other areas are all in the same group of time; only area 602 is a little bit faster than the others, probably because of its special location.

10. **Slope:**

This is an individual task done mainly by the surveyor A or by the surveyor B if he finished the rest of his tasks. In some cases the surveyor makes an estimation of the slope, so that it is not possible to register this time and it is represented by a zero. On the other hand this is a task that takes very short time, as average less than a minute.
We can make 2 groups. The faster group would be composed by areas 585 and 57 and the other group, by areas 602, 462 and 223. The main time consuming factor is the work system; estimating or measuring. We have the fastest and the slowest times made by the same team, but they changed the method since there was a higher slope in area 602 that is more difficult to estimate.

11. **Detailed measurement of trees (Detailed tree):**

One or both surveyor could do this task; it is usually measured at the end so the work is done according to each specific situation. Within the area 585, where we have most of the observations for this element, both persons did the work but we can study an alternative method working individually.
This element is measured only in certain cases when there are trees out of the definition of forest. Thus that in many areas there is no data about this element.
The time for this task would vary very much depending on the number of trees they have to count that could vary from a single tree to lots of them.

We cannot compare different areas since only area 585 present this element.

12. Lichen:

The surveyor A measures this element if “lunglav” *Lobaria pulmonaria* or “skrovellav” *Lobaria scrobiculata* are present in the sample plot. Usually surveyor A checks for them during the rest of the tasks, especially during the study of the ground cover in the big plot. If presents later on, more detailed information would be taken. During this study we have not registered any time for this element since Lichens were not found in any of the areas studied.

13. Mountain forest types (Mountain types) :

The surveyor A does this task but assistance could be required especially during the first identifications of a new type of mountain forest.
We have a presence of this element only in the mountain areas (585 and 602). There is no significant difference in time between those ones and the time consuming is very short.

14. Natura 2000:

The surveyor A does this task but assistance could be required especially during the first identifications of a new Natura 2000 ecotype.
We have a presence of this element only in the mountain areas (585 and 602). There is a significant difference between those two areas, taking area 602 longer time.

15. Mountain species (Mountain sp.):

The surveyor A does this task but assistance could be required especially during the first identifications of the species.
Species of plants included in the list were found only in area 602.

16. Photo documentation (Photo):

The photo documentation is done individually since the nature of this task makes it difficult to do it two persons at a time. The only exception is that one of the team can help to introduce the information in the handheld computer. Of course in some occasions assistance can be helpful meanwhile the photos are taken.
The different teams use different methods. The most common method is the used by teams 1, 2 and 4. Here, surveyor B take care of taking the pictures meanwhile, surveyor A is doing other tasks. Team 3 has instead the same person taking the pictures during the whole day since the other person is just waiting during this time and the responsibility of the pictures will be given to the other team member every second day.

17. Present or absent species in the small sample plot (Small sp.):

This element is done by the surveyor B in every area, it’s done individually, and it’s common to have some assistance from the other surveyor to ensure that the species are identified right. Area 602 is covered by only a few species and some parts were covered by rocks or snow due to the high altitude where it is located, this reduces the time consumed to less than in any other area. We can find a significant difference in time with the areas 223 and 585, both of them consuming more time. Area 585 is located in the mountain areas but at a lower altitude and with a high water level in the ground. There we can find a bigger variety of plants, especially sphagnum species. This slows down the identification, even though the team has a deep knowledge of botanic.
Area 462 is probably faster because of the non-variation of the present species within this area, and also within the surrounding areas, this makes it very constant and the identification easier.

18. Estimation of coverage in the small sample plot (Small cover):

This assignment is done by surveyor B in every area, carried out individually, and it's rare that assistance is needed.
The area 223 takes longer time to estimate than any other; there is a significant time difference between area 223 and the two areas 602 and 462. In those two areas, the time needed is clearly less. Area 602 is characterized by only a few species that cover the ground. Rocks or snow in many places covers the ground; this makes it easy to measure those plots.

19. Other:

Both surveyors are affected by this element. And it doesn't seems to follow any clear pattern since many times this element is related to non clear tasks and include also, packing and preparing the equipment for the next area or line.

20. Assistance:

This element could be required at any moment and for any surveyor. Usually one surveyor requires the help of the other for certain circumstances when they need a second opinion to ensure the observation.
In all the areas but the area 462 it is the surveyor B who provides assistance in many of the occasions. In areas 462, 585, 82 and 57 very short times of consultation between the surveyors are needed. Area 602 present the longest time for assistance, this might be because of the special conditions in the area that makes the surveyors more insecure.

21. Waiting:

This element occurs when due to the nature of the tasks one worker is limited to wait until the other one finish what he is working with. Waiting time is highly avoided so in case there is no specific task for the worker to do, he can pack the equipment or even start with tasks for the following line for instance. This is not present in every area. Area 223 present the longest waiting time related to the method used for taking the pictures.

3.2.2 Time study of the lines

The result obtained for the lines had been summarized presenting first the statistical analyses and then the mean values obtained from them and the direct average of the initial data, for each area and work element. The influence of the accessibility to the beginning and end of the line is presented. The elements total time and intersection present a linear relationship with the number of intersections so a regression to obtain this relationship is also presented.

3.2.2.a Statistical analyze

Table 3.6 shows the results of analyze of the variance obtained from SPSS for the total time of the lines. The adjusted R Squared of 0.681 means that the model explains over 68 percent of the data. On the other hand the value of the significance for the area, number of intersections and access of the starting and finishing point (OBS) is less than 0.05 that means that there is a statistically significant difference depending on them. Through the analyze, the effect of those three factors will be explained.

Table 3.6 line ANOVA values

Source	Type III Sum of Squares	DF	Mean Square	F	Sig.
Corrected model	49189703,7a	9	5465523	13,837	0
Intercept	11048619	1	11048619	27,972	0
Area	13710213	5	2742043	6,942	0
OBS	7288191,4	3	2429397	6,151	0,001
N.INT	13825620	1	13825620	35,003	0
Error	17774382	45	394986,3		
Total	239858181	55			
Corrected total	66964086	54			

a. R Squared = 0.735 (Adjusted R Squared = 0.681)

3.2.2.b Data presentation

In this section is presented data obtained from the time study of each work element of the lines. The influence of the area, number of intersections and access of the starting and finishing point of the line will be showed

The first factor to study is the effect of the area. In table 3.7 the mean values of each work element in each area are presented.

Table 3.7 Means values of the time consuming of each work elements of the lines, the elements “intersection” and “Total” are corrected in the model for a number of intersections equal to 1,24. The rest of the elements are presented without any correction. The line is done in a team so the time presented is the time that two persons need to make one line. The time is exposed in time/two persons for every work element and the total

Work element	Area 57	Area 82	Area 223	Area 462	Area 585	Area 602	Mean
1) Walk &navigate	111	123	130	193	113	41	119
2) Start	31	2	79	89	64	50	52
3) Wait	278	209	350	1186	202	74	383
4) Walk	430	173	413	595	442	596	442
5) Intersection	153	646	535	158	307	271	345
6) End line	48	99	149	111	114	95	103
7) Stop line	0	63	12	0	0	34	18
8) Obstacle	0	1128	113	0	0	86	221
9) Re-staring line	0	206	75	0	0	0	47
10) Delayed	0	0	24	30	6	13	12
11) Others	0	17	0	4	41	0	10
TOTAL	**813**	**2752**	**1553**	**2344**	**1427**	**1436**	**1721**

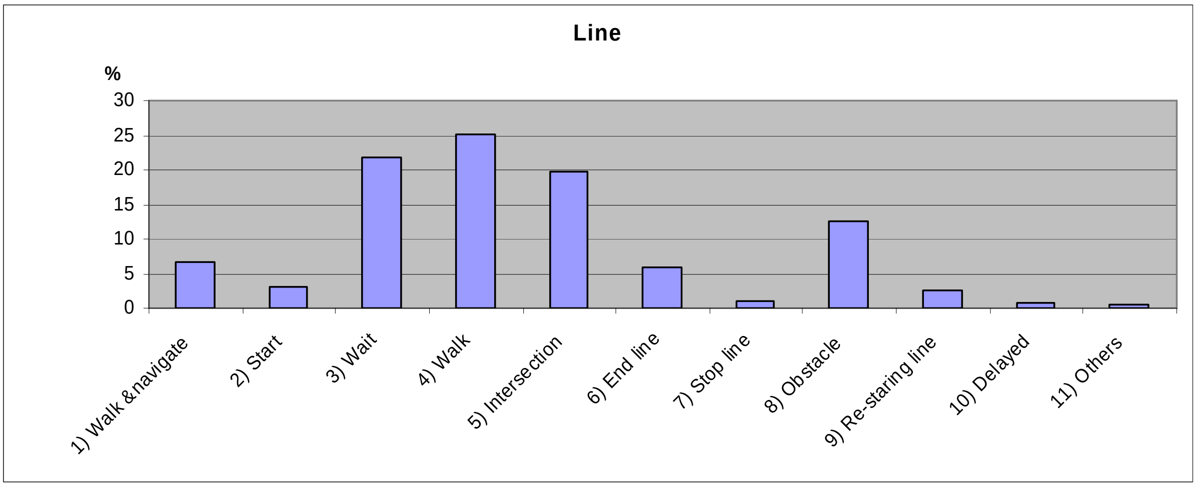


Fig. 3.2 mean time consumed by the different work elements of the lines expressed as percent of the sum of all elements

There are some zones that are not accessible, like a lake, crops fields or private land. When a line comes to a inaccessible zone it is needed to finish the line by the information in the map (end-map). When the location of the start of the line is not accessible it is started by the information on the map (start-map). When both start and end of the line are inaccessible but a portion in the middle is, the line is called e+s-map.

Table 3.8 shows the average time in minutes for the lines depending on the accessibility of the beginning and/or the end of the line. The time had been corrected in the model for a number of intersections equal to 1,24.

Type of line	end-map	e+s-map	normal	start-map
TOTAL	1159	868	1803	3053

Total time:

We can establish three groups according to the significant differences between the total times for the lines in the different areas. The fastest group only consists of area 57. The medium group include the areas 223, 585 and 602 and the slowest group includes areas 426 and.82. Area 82 is located in agricultural land with many lines that start and /or finish in the map. As table 3.8 shows we can find some differences according to their accessibility. The lines that start in the map show a significant difference with the rest of the cases. Those lines take longer time than the other ones.

1. Walk and navigate:

This element takes somewhat more than one minute in every area but area 602 where this goes particularly faster. We can find significant differences in time between areas 602 and 462 that on the other hand is the slowest one with almost two minutes.
Area 602 was done with GPS, because of the rocky terrain, which makes it difficult to use the line.

2. Establish and register the starting point (Start):

This element takes less than one minute for every area. The only significant different is between the fastest area (82) where the time needed is just a few seconds and the area 462 where it takes nearly one minute.

3. **Wait:**

In some areas, where there were not so many intersections, the person walking in front leave an stick every 50 m. and don’t wait until the person in the back arrive, but keep on walking. Those areas: 57, 82 and 585 have a time about two minutes. In areas 223 and 462, due to a bigger amount of intersections the person in front had to go back and help the other with the registrations so the time is longer. In Area 462 the time is particularly much longer with almost twelve minutes though the terrain was not more complicated than in the other areas, but the whether was very wet and uncomfortable. Area 602 was the fastest; they were using the GPS to navigate due to the complicate terrain so the waiting time was dramatically reduced since there was no need to wait to stretch the line

4. **Walk:**

The slowest areas are area 602 and 462 since it took almost six minutes, and the average is about four and a half minutes. The fastest area is 82 with less than two minutes, but in this area there were many lines that start or finish in the map which made the walking distances much shorter.

5. **Register intersection (Intersection):**

Areas 82 and 223 differ significantly in time from all the others, but not between them. They need almost double time than the other group where the rest of the areas are included according with their time consumption. Areas 82 and 223 have more intersections and those also take longer time.

6. **Register the end of the line (End line):**

The average time for this task is about one minute and there are no differences in time between the areas.

7. **Register Stop of the line (Stop line):**

This element appears only in areas 82, 223 and 602 and for all of them the time was less than one minute.

8. **Walk around the obstacle (Obstacle):**

We find no obstacles in areas 57, 462 and 585. Almost all the registrations of obstacles are concentrated in area 82 where the time consumed was longer than in areas 223 and 602. These two last ones had really few obstacles and it took short time to walk around them.

9. **Re-start line:**

Only areas 82 and 223 include this element, both of them being similar in time consumption. Area 602 had only one obstacle but this was at the end of the line so it was not needed to re-start the line after this.

10. **Delayed:**

Really few delays were found in the lines.

11. **Others:**

Not many other activities were found in the lines.

3.2.2.c Linear regression depending on the number of intersections

With this test we aim to find the relationship between the total time consumed in a line and the number of intersections observed on it, also the relationship between the time consumed in the work element "intersection" and the number of intersections observed. Those relationships appear to be linear.

The equation that links the total time consumed in the line and its number of intersections is:
t = 1137 + 514i + e

t = total time expended for a line in centiminutes
i = number of intersections in the line
e = error

The model has an adjusted R^2 of 0,416

That equation obtained from the model means that every line takes about 11 minutes, and every intersection would add about 5 minutes.

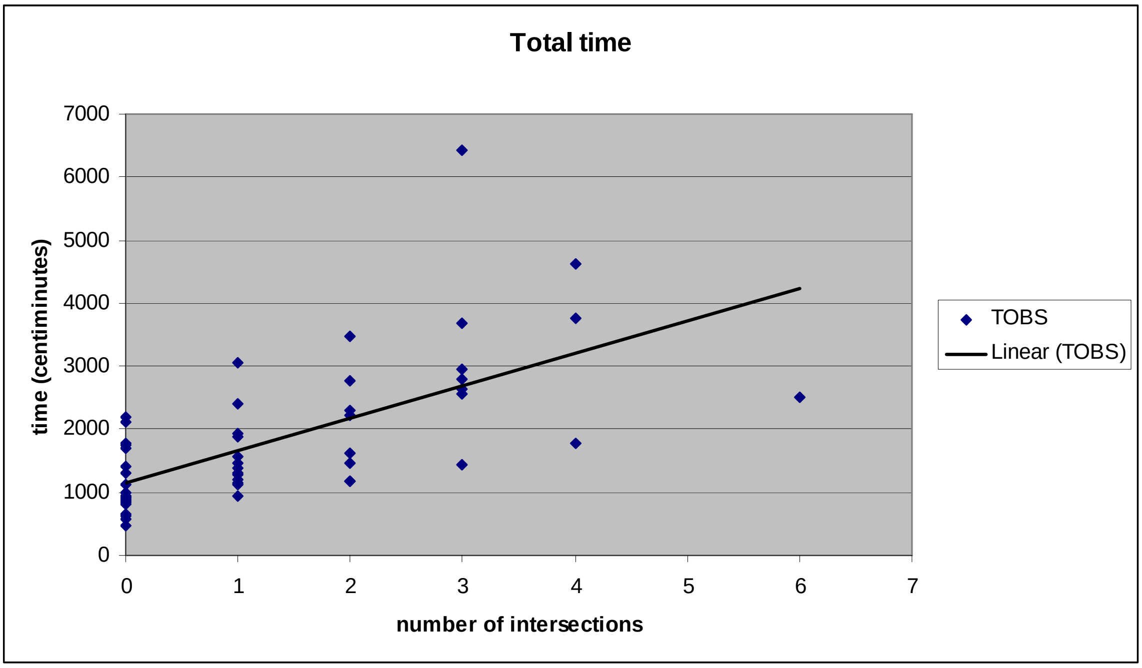


Fig. 3.3 shows the relationship between the total time consumed in a line and the number of intersections observed on it. Each dot represents each line timed in this study. A trend line had been added and corresponds with the representation of the model.

The equation that links the time consumed in the work element "intersection" and the number of intersections observed is:

y = 46 + 271 i + e

y = time expended to measure all the intersections in a line in centiminutes
i = number of intersections in the line
e = error

The model has an adjusted R^2 of 0,697

That equation obtained from the model means that the time needed to measure the intersections had a fix component of less than half minute, and every intersection would add less than 3 minutes.

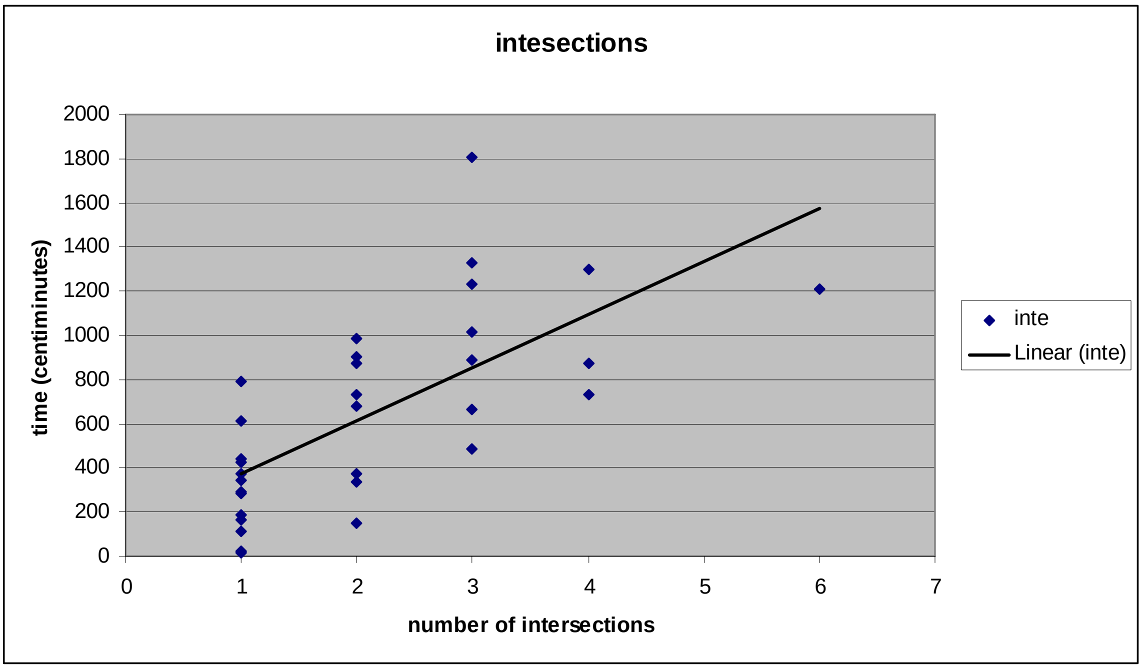


Fig. 3.4 shows the relationship between the time consumed in the work element "intersection" and the number of intersections observed. Each dot represents each line timed in this study. A trend line had been added and corresponds with the representation of the model.

We can see that the time added for each new intersection is not the same for the total time of the line and the work element "intersection" that means that each intersection influence also the other work elements of the line and not only the time to measure it.

3.3 <u>Time study of the administrative work</u>

The average time spent every day in each team in the administrative work is 4202 centiminutes, which means about 42 minutes.

3.4 <u>Estimation of Price or the work elements</u>

The cost of the work inventory depends on so many factors. Here is presented an approach based on the proportional distribution of the cost by the time that every work element takes in the field inventory. The total cost column shows the cost generated by the whole fieldwork divided to the elements according with their weight. The column Variable cost is counting only the cost of the time expended directly by the field teams

Table 3.9 presents the estimation of the cost for the work elements of the plot in Swedish krona.

		TOTAL COST			VARIABLE COST		
Work element	Weight	Season	Area	Plot	Season	Area	Plot
1) Walk	0,0236	79 028	693	58	50 242	441	37
2) Start	0,1664	557 629	4 891	408	354 507	3 110	259
3) Division	0,0153	51 128	448	37	32 504	285	24
4) Big ground	0,0597	199 984	1 754	146	127 138	1 115	93
5) Big bushes	0,0076	25 551	224	19	16 244	142	12
6) Big forest	0,0814	272 986	2 395	200	173 548	1 522	127
7) Land use	0,0077	25 655	225	19	16 310	143	12
8) Influence	0,0095	31 900	280	23	20 280	178	15
9) Soil	0,0373	124 866	1 095	91	79 382	696	58
10) Slope	0,0071	23 887	210	17	15 186	133	11
11) Detailed tree	0,0110	36 920	324	27	23 472	206	17
12) Lichen	0,0000	0	0	0	0	0	0
13) Mountain types	0,0025	8 246	72	6	5 242	46	4
14) Natura 2000	0,0071	23 848	209	17	15 161	133	11
15) Mountain sp.	0,0005	1 768	16	1	1 124	10	1
16) Photo	0,0269	90 256	792	66	57 379	503	42
17) Small sp.	0,0432	144 855	1 271	106	92 090	808	67
18) Small cover	0,0554	185 828	1 630	136	118 138	1 036	86
19) Others	0,0620	207 934	1 824	152	132 192	1 160	97
20) Assistance	0,0113	37 785	331	28	24 021	211	18
21) Wait	0,0141	47 296	415	35	30 068	264	22
TOTAL	0,6496	2 177 351	19 100	1 592	1 384 229	12 142	1 012

Table 3.10 presents the estimation of the cost for the work elements of the line in Swedish krona.

		TOTAL COST			VARIABLE COST		
Area	Weight	Season	Area	Line	Season	Area	Line
1) Walk &navigate	0,0228	76 538	671	56	48 658	427	36
2) Start	0,0101	33 890	297	25	21 545	189	16
3) Wait	0,0738	247 544	2 171	181	157 373	1 380	115
4) Walk	0,0850	285 018	2 500	208	181 198	1 589	132
5) Intersection	0,0803	269 287	2 362	197	171 196	1 502	125
6) End line	0,0198	66 364	582	49	42 190	370	31
7) Stop line	0,0035	11 759	103	9	7 475	66	5
8) Obstacle	0,0426	142 768	1 252	104	90 763	796	66
9) Re-staring line	0,0090	30 229	265	22	19 218	169	14
10) Delayed	0,0024	7 911	69	6	5 030	44	4
11) Others	0,0020	6 810	60	5	4 329	38	3
TOTAL	0,3504	1 174 658	10 304	859	746 777	6 551	546

Table 3.11 presents the estimation of the cost for the whole inventory

		TOTAL COST			VARIABLE COST		
Work element	Weight	Season	Area	Plot + line	Season	Area	Plot + line
Plot + line	1,0000	3 352 009	29 404	2 450	2 131 006	18 693	1 558

DISCUSSION

There are significant differences in the time consumption between the areas for the total time in the sample plots as well as in the lines. Almost all of the work elements present differences in time between areas. In table 3.2 the difference is statistically significant if $p< 0,05$. The differences in time are caused by, for instance: the region and the particular location of each area as well as human factors like the performance of the team, their skills, motivation and they are also influenced by the weather and other work conditions. In many occasions it is not easy to separate one effect from another, so it is necessary to count all of them together and try to find their different importance.

The working systems for the teams studied were very similar. There were only a few differences between them, which may cause some of the differences in time consumption. On the other hand it could be desirable for each team to make a few adjustments of the method in order to fit their personal skills. Since the teams did not use so many different methods, it was not possible to compare the effectiveness of them.

When analysing the data, it was found that especially the lines, does not follow a normal distribution. This fact and the fact that in some cases there were only a few number of observations, affects the statistical analysis. This will be discussed later for each particular case.

Many of the observations in the inventory are estimations, for example the coverage of plants or rocks. It is not possible to know the real value, and therefore it is difficult to know the accuracy of the measurement. Accuracy could be in contradiction to fast measurement, but in this study it is not possible to know this for a fact. Every worker in this project has the right education and has been trained for this work, therefore it is necessary to assume that every measurement has the same precision, or at least it is within the requirements.

4.1 Different methods used

There were only a few differences in the methods used by the field teams, which will be presented here.

4.1.1 Distribution of the tasks in the work element "start"

All the teams distribute the tasks, working both as a team and individually, with almost no differences. One of the teams started out working together, leaving the individual part as the last tasks in the plot, with this they aim to avoid waiting time since they do not know witch surveyor will be ready first and both of the surveyors can do this task individually. It can be inconvenient to leave the measurements of "start" undone, since it identifies the location of the plot and it is problematic to retake any missing information. On the other hand it can be practical to have a task left at the end, as a buffer to avoid waiting time, but any task left at the end can be use in this way Thus it is recommended to do all the tasks of "start" at the beginning to avoid missing information.

4.1.2 Photo documentation

The most common method is for surveyor B to take the pictures since surveyor A is doing other tasks. An alternative method is to take the pictures directly after locating the centre of the plot and before starting the registrations. The same person takes the pictures during the whole day to avoid missing the pictures in a plot. A side effect of this method is that the person not taking the pictures is just waiting. It is easier to take the pictures without any equipment or people in the plot, but the data do not show that it is faster. So the time delay this creates would recommend using the first method.

4.1.3 Navigating in front of the lines

The work in the lines is performed as a team; one of the tasks is walking and navigating in a strait line to mark out the inventory line. In most of the cases, the surveyors change place every second line (200 m.). An alternative method is to change the person walking in front when half of the line has been walked (100 m.). From the observations of this time study the alternative method is slower, so the first method is recommended. This time had been registered under the work element "wait" since waiting time for the person in the back of the line correspond with the person in front of the line navigating.

4.2 Time consumption in the plots

4.2.1 Total time

A plot that has to be divided increase the time consumed with about 20 or 25 minutes, not only because of the time it takes to register the division, but mainly because many of the measurements has to be repeated in each division of the plot. On the other hand, since the tasks for surveyor A has to be repeated, surveyor B usually already has finished, so he can help with them. It could be interesting to make a deeper study about this relationship and a regression to see it dependency of the number of divisions. In this study there are only five plots with division; two of them are located in area 602 where the division does not affect the total time very much because it was just snow and rocks. It is not possible to get more than this particular information about the present cases. Other elements could be compared with some factors like the data obtained in the NILS program but this is out of the boundaries of this study.

Area 223 has the highest time consumption, being 15 minutes above the average. Among other factors it seems that the team working there was affected by the study. This team had a large experience in field inventories, and since they were doing every measurement really carefully they may have increased the time consumed. This team has also some small differences from the work methods of the other teams, like the way of taking the pictures. This will be discussed with each work element. On the other hand, it is important to see that the data from area 223 may raise the average values presented here. For the rest of the teams, the normal working time does not seem to have been affected, but it could be that some of them speed up their work because of the presence of the study man.

Area 585, as we can see in table 3.4, includes every work element in the list except lichen that has not been present at all during this study. Here we have some special tasks for the mountain areas as well as "detailed tree measurement" that rise the time for this area. Area 602, which also was in the mountains, presents a shorter time because it was above the tree growing altitude. Here there was no detailed tree measurement and the number of plants species was much reduced.

There is only one registration of plots in area 82 in this study since the other registration had division and was therefore excluded from the analyses in order to compare time differences between the areas. The rest of the plots within the area that were visited this day, were out in inaccessible fields. So the meaning of the figures of area 82 is particular and it is not statistically representative.

4.2.2 Work elements

1. **Walk & navigate (walk):**

The team working in area 462 seems to be slower than the others at navigating; it is possible to see this also for the lines. The area had some slopes, the weather conditions were very wet and it made the work harder than usual. This or the work performance itself could make those differences. The lack of good GPS network may delay this element, especially in dense forest areas. This is the case of areas 223 and 462.

2. **Start:**

Every team follows a similar structure with a shared part and an individual part. There are some small differences between teams, but there is no difference in time for the shared part and only small ones for the individual part. There is a possibility to study different methods combining the shared part with the individual, or even doing everything together or individually.

3. **Division of the plot (Division):**

There are not many plots with division included in this study. Some of the time registered in plots corresponds to the time it takes to decide whether to divide it or not in plots that were not divided at the end. The time it takes to divide plots is very stable and do not seem to be affected by the area where they are located.

4. **Ground cover in the big sample plot (Big ground):**

The time for this work element depends very much on the difference of emphasis the teams put in checking aspects that can be registered later in other work elements. The differences in area 223 could be explained this way. The differences of importance and its time consumed cannot be measured in this study.

5. **Bushes in the big sample plot (Big bushes):**

The time consumed for this element is directly related to the importance of this stratum within the rest of the vegetation, this is the case in area 585. The time consumption seems to be increasing when we move north in Sweden.

6. **Forest and trees in the big sample plot (Big forest):**

This task in area 223 seems to be affected by the influence of this study and make it slower, since many measurements can be estimated or measured and put more or less intensity on it.

7. **Land use in the big sample plot (Land use):**

Within the times for each plot we find that it is common in every area that there is always one plot that takes longer time. This means that in the first plot of every area the surveyors needs a little more time to figure out the land use, but later on, it is possible to extend the conclusions to the following plots and that takes shorter time to decide. This can also be extended to the total time consumed in the plots.

8. Measure influence (Influence):

Areas 223 and 462 are dominated by forest. There are many signs of human influence present and those ones have to be evaluated and measured. This rise the time consumed.

9. Soil description (Soil):

The time consumed for this task depends mainly on the characteristics of the soil that define whether it is easy to take the samples or not. On the other hand it depends also on the skills of the surveyors to identify soil types.

10. Slope:

This element could be included into the soil description, but it might be interesting to measure it separately. It is not difficult to calculate the inclination of the slopes based on aerial pictures, so NILS can decide whether to measure the slope in the field or obtain the information from maps. The time consumed in the field depends basically on whether the slope is estimated or measured and that is up to the team to decide. But it also depends on the place, since steeper slopes are more difficult to estimate and actual measurement is needed.

11. Detailed measurement of trees (Detailed tree):

The time for this task would vary very much depending on the number of trees that has to be counted. It can vary from a single tree to lots of them depending on the particular situation in each location of the plot.

12. Lichen:

The surveyors look for those lichens meanwhile they are doing the rest of the tasks. It is helpful to know the type of environment they live in, thus paying more attention in those areas and look for tree species where those lichens usually live. During this study we have not registered any time for this element since lichens were not found in any of the studied areas.

13. Mountain forest types (Mountain types):

This measurement is necessary only in the mountain areas. The first plot takes longer than the rest since it is necessary to check more carefully which definition fits the area best.

14. Natura 2000:

In the first plot in area 602, there is one value much higher than in the rest. This value raises its average. Probably the team had problems to identify this ecotype for some reason. So, the difference in time found between plots may be just a matter of fact.

15. Mountain species (Mountain sp.):

Only area 602 presents this work element so is not possible to extract many conclusions but what the average time gives.

16. Photo documentation (Photo):

Team 3 in area 223 has the same person taking the pictures during the whole day while the other person is just waiting during this time. This causes an increase of the waiting time for the other person. Area 602 presents some difficulties due to the fact that it was hard to nail the pole in the centre of the plot that should appear in the picture, which rise the time consumed.

17. Present or absent species in the small sample plot (Small sp.):

The time consumed for this work element depends mainly on the total amount of different species present in the small sample plot and how rare or common they are. Of course good botanic skills of the surveyors will give faster measurements. Forest areas, as well as areas situated very high, had less variety of species so the time for these areas will be shorter.

18. Estimation of coverage in the small sample plot (Small cover):
The amount of different species as well as the disposition of them in layers, affects the time needed for this work element. The time needed here is related to the time needed for the previous element.

19. Other:
This work element is related to unclear tasks and includes saving data and going through menus in the handheld computer, but also packing and preparing the equipment for the next area or line. Therefore, the person that finishes first can do some of these tasks though they could probably be done much faster. It seems that the time it takes to do it has more to do with the difference in timing between both surveyors. The time consumed for this element is quite important, so good arrangement would help saving time.

20. Assistance:
The consultations between the surveyors are concentrated on the first plots in the area but could be necessary at any moment. How the assistance is distributed probably has to do with the personal skills and experience of the workers.

21. Waiting:
In area 223 there is a relationship with the task called “photo” and the working method of the team. When one surveyor takes pictures the other is just waiting. In area 602 there is a large measurement of 10 minutes that rise the average time for this area. Short waiting times could be found, it seems that the more flexible the working method is the less waiting time appears.

4.3 <u>Time consumption in the lines</u>

4.3.1 Total time

The time in the lines depend on the area, the number of intersections and whether it starts and/or finish in the map due inaccessible parts.

The areas that took longer time were areas 462 and 82. Area 82 had many lines starting and/or finishing in the map, which means that many of the lines were hard to access so moving towards the line was the biggest time consumer. Area 462 had bad weather conditions when the study was done. This probably made it harder than usual walking through the forest and could be responsible of this difference of time. The method to measure lines is different for this team, than for the other teams. They change the person in front, in the middle of the line instead of just once every second line. This will also affect the waiting time when the person in front is navigating the line and the total time.

According to the regression for the lines with intersections, the time for each line consist in a fix part of 1137 centiminutes plus 514 centiminutes per each intersection. The time that each intersection adds to the work element ‘intersection’ is only 271 centiminutes, which means that each intersection also affects other work elements by adding time to them. The person walking in front has to go back to help measuring and this is probably why the total time increases more than just the time needed for the registration of the intersection.

The lines that ends in the map or both starts and ends in the map where faster to measure than the normal ones, since the walking distances are shorter and could be reduced to only an intersection with a road or a river. The lines that starts in the map took longer time to measure than the others, because the lines beginning point was not easy to access, so they spent much time walking to the beginning of the line.

4.3.2 Work elements

1. **Walk and navigate:**

The method used in the area 602 was different from the other areas. It was hard using the line, because the terrain was filled with rocks and the line got stuck very often. For that reason, they used the GPS to navigate instead. This made it much faster but accuracy was lost, maybe this was not so important in this area, since it had hardly any intersections.

2. **Establish and register the starting point (start):**

This element can be done meanwhile the work element “walk and navigate” so the time consumed depend on the performance of the work but also on the time needed to find the coordinates with the GPS. Sometimes take a while to get the satellites network.

3. **Wait:**

The person in the back is waiting while the person in front is navigating in a straight line. The time needed depend on the time the person in front takes to walk with the compass the 200 metres line. Thus the person in the back was followed and it was not possible to see if the person in front had any delayed time for any reason. In area 462 the whether was very uncomfortable since it had been raining when the study was done. The method used was to change the positions between walking in front and in the back, that differs to the other teams method, which may rise the time consumed. In area 602.there was no need to wait to stretch the line, since GPS was used to navigate due to its complicate terrain. This resulted in a dramatically reduced waiting time.

4. **Walk:**

In area 602 it was complicate to walk. It has slopes, rocks and snow. The time measured increases because of this. Area 462 may take longer time because of the weather conditions. Areas where there are many lines that start or finish in the map like area 82 makes the distances to walk much shorter and also the time spent on it.

5. **Register intersection (intersection):**

It generally takes longer time to register the intersections closer to populated areas, and there are usually also more intersections.

6. **Register the end of the line (end line):**

This takes similar time and relatively short time for every line.

7. **Register Stop of the line (stop line):**

This element appears only in areas 82, 223 and 602 and for every line is done pretty fast.

8. Walk around the obstacle (obstacle):

Obstacles in area 82 were a lot of fields and small creeks. It took quite long time to avoid the fields and get to the intersection of the lines with the creeks that often was the only part of the line to measure. The other areas had really few obstacles and it took short time to walk around them.

9. Re-start line:

Only areas 82 and 223 present this element and both were similar in time consuming

10. Delayed:

Really few delays were found in the lines.

11. Others:

Not many other activities were found in the lines

4.4 Estimation of Price or the work elements

The approach of this study don't aim to count every factor in detail but to give an idea of the value of each work element, to put a price label that makes it easier to compare. On the other hand if the goal is to reduce costs, then it is needed to work with all the aspects that had an influence in each work element as well as other logistics aspects.

The time spent in the actual field inventory is only one third of the total time the teams are paid for. Within the total time there are same parts that are fixed, like travelling home, or the right to vacations. But there is a great amount of time spent in moving to and from the areas every day, as well as other times not directly involved in the data collection but necessary where it is possible to save a lot of time by a good planning of the work.

Within the work elements, some have a higher importance, so the actions affecting them would mean more for the budget. We can take a couple of examples.

The work element 'start' take over half million SEK, so any improvement in the performance or in the distribution, within the team or in the individual work, would be greatly noticed. This task is quite flexible in its performance, some combinations of individual and team work are possible, and so some tests should be done in order to find out the most effective distribution.

The element 'others' call the attention, since it is taking about 200 000 SEK and is such an imprecise task, that seems to be related to the timing of both surveyors. It would be worth to study all the possibilities to reduce this time. The flexibility of the working method by helping each other and shearing the tasks would help to avoid waiting time, or non profitable work of bad timing.

The work element "big forest" cost about 275 000 SEK. It is common that the personal have a biology oriented profile, so a better training and instructions on the forest measurements could reduce the time spent here. On the other hand some measurements can be estimated, like the height of the trees or its age, using estimation instead of precise measurements would reduce the time consumed but also the accuracy.

4.5 Suggestions

This study together with following ones could give very good results. The potential for more comparisons and development of a better understanding of the distribution of resources can be great.

There is an enormous amount of data collected from the field teams, if this data from the time study is merged with the inventory data from the studied plots and lines a new data analysis resulting could explain more of the variation in time consumption. And this could be applied when planning future inventories. In the particular case of NILS, it would be also interesting to find the relationships with information obtained from the photo interpretation so it could be a way to forecast the field season more accurately from the base of the photo interpretation done.

For the season 2005 new software for the handheld computer will be used to collect the data, which would help to improve the efficiency of the teams. This since the new one seems to have many advantages with respect to the old one. The main improvements are faster and easier movements within the menus, help registering the coverage, as well as checking that all the information required in the menus have been fulfilled.

To incorporate a time registration in the program used in the handheld computer. This would provide a volume enough of time registrations to run the statistics safely and with almost no extra cost for it. This would be limited for the program used by the surveyor, but would be easy and inexpensive.

In order to improve the methodology for the field inventory it would be necessary to perform some comparative studies that test different methods. Since no big differences were found in the methods used in this study, it would be necessary to design some alternatives and test them. The time study should be able to follow both surveyors at the same time; the use of time sampling could be a good alternative.

During the analyses of this study, one of the difficulties found was having a good view of the whole fieldwork and not only at the separate tasks. The study of the work elements in the field inventory was pretty intensive, but sometimes it was difficult to link all the parts of the work together. Thus a continuous time measurement or some kind of time stamp included in the registrations would help to measure the length of the task and also to know the time of the day when it happened. So it would be easier to compare this with the rest of the work.

The accuracy of the measurements in the inventory is wished to be correct information. There is a control team within NILS that measure again some of the areas done by the field teams. If we want to use this information together with the time study it could be possible to have the control team working in the same areas that are chosen for the time study.

The average time spent every day travelling is over a fourth of the ten hours working day. It would be interesting to investigate how to reduce this travelling time. Finding better places to stay or better distribution of the working days in order to avoid situations when the proportion of the time the travelling takes and the time the field inventory takes is not favourable. This responsibility belongs now to the field teams, but some instructions or even compensations should be considered.

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APPENDIX I

This appendix contains all the registrations taken in the field during the study. It is separated into plots and lines.

The chart for the plots shows the information about the team, area, identification of the plot, number of divisions, the surveyor that was followed in this plot, all the work elements and the total time.
The time of the work elements in the plots is presented in centiminutes per person and the total is presented in centiminutes per team (two persons)

Average 1 includes plots with and without division but not the plots not done because they were not accessible. This is the average of the plots actually done.

Average 2 includes plots with and without division and also every plot in the areas of study even thus they were not accessible. This is the average of the plots for the whole inventory assuming that occurrence of not accessible plots is constant.

The chart for the lines shows the team, area, identification of the line, type of starting or end of the line, number of intersections, all the work elements and the total time.

The time of the work elements and the total time in the lines is presented in centiminutes per team (two persons)

PLOTS

team	area	plot	Nº divi	surveyor	walk	start	division	big ground	big bushes	Big forest	land use	influence	soil	slope	det. tree	lich	mount. type	Nat. 2000	mount. Spp	photo	small sp.	small cover	other	assist	wait	TOTAL
1	585	2	1	1	170	930	0	897	210	478	33	0	410	0	0	0	137	142	0	0	0	0	393	0	0	3800
1	585	3	1	2	88	1230	0	0	0	0	0	0	0	0	0	0	0	0	0	468	496	737	359	90	0	3468
1	585	4	1	2	117	1150	0	0	0	0	0	0	0	0	0	0	0	0	0	307	785	464	643	0	0	3466
1	585	5	1	1	185	1088	0	830	168	840	215	15	476	30	160	0	115	65	0	0	0	0	139	0	0	4326
1	585	6	1	1	88	910	0	520	98	520	25	17	282	72	129	0	72	17	0	0	0	0	152	32	0	4102
1	585	7	1	2	0	2655*	0	0	0	0	0	0	0	0	102	0	0	0	0	0	0	267	0	0	0	3945
1	585	8	1	2	0	988	0	0	0	0	0	0	0	0	0	0	0	0	0	443	1318	989	492	0	0	4230
1	585	9	1	1	145	735	0	628	135	448	28	22	591	0	89	0	0	130	0	0	0	0	476	0	0	3427
1	585	10	1	1	122	778	0	458	228	735	33	38	237	109	0	0	0	0	0	0	0	0	243	0	0	2981
1	585	12	1	2	147	1662	0	0	0	0	0	0	0	0	0	0	0	0	0	322	1056	1262	450	0	0	4899
team	area	plot	Nº divi	surveyor	walk	start	division	big ground	big bushes	Big forest	land use	influence	soil	slope	det. tree	lich	mount. type	Nat. 2000	mount. Spp	photo	small sp.	small cover	other	assist	wait	TOBS
1	602	1	1	2	0	1177	0	0	0	0	0	0	0	0	0	0	0	0	0	412	0	0	78	875	113	2655
1	602	2	1	2	187	1265	0	0	0	0	0	0	0	0	0	0	0	0	0	402	638	736	77	0	0	3305
1	602	3	1	1	0	1035	0	620	0	0	30	30	0	188	0	0	15	223	0	0	0	0	435	0	0	2576
1	602	5	2	1	0	758	788	446	0	0	33	58	313	0	0	0	110	31	0	0	7	0	123	0	0	2667
1	602	6	1	2	187	1613	0	0	0	0	0	0	0	0	0	0	0	0	0	407	115	294	224	0	0	2840
1	602	7	1	2	80	868	162	0	0	0	0	0	0	0	0	0	0	0	0	1090	0	404	316	0	0	2920
1	602	8	1	1	110	820	0	647	0	0	22	17	204	112	0	0	15	1063	0	0	0	0	346	0	0	3356
1	602	9	2	1	255	992	672	505	0	0	102	85	330	102	0	0	130	69	0	0	0	0	28	237	0	3507
1	602	12	1	1	97	885	0	325	0	0	0	0	189	90	0	0	45	108	137	0	0	0	142	347	109	3457
team	area	plot	Nº divi	surveyor	walk	start	division	big ground	big bushes	Big forest	land use	influence	soil	slope	det. tree	lich	mount. type	Nat. 2000	mount. Spp	photo	small sp.	small cover	other	assist	wait	TOBS
2	462	1	1	1	340	684	0	338	125	834	105	83	264	83	0	0	0	0	0	0	0	0	695	0	0	3551
2	462	2	1	2	160	1196	0	0	0	0	20	23	212	47	0	0	0	0	0	123	375	414	169	0	70	2809
2	462	3	1	2	247	1372	0	0	0	0	0	0	0	0	0	0	0	0	0	285	389	486	413	32	102	3326
2	462	4	1	1	297	482	0	447	73	887	133	37	132	110	0	0	0	0	0	0	0	0	378	0	0	2976
2	462	5	1	1	200	639	0	367	55	1120	72	27	115	73	0	0	0	0	0	0	0	0	273	0	30	2971
2	462	6	1	2	342	1157	142	0	0	0	0	0	0	0	0	0	0	0	0	345	401	668	356	0	0	3411
2	462	9	1	2	260	1313	0	0	0	0	35	113	209	0	0	0	0	0	0	143	254	363	249	0	0	2939
2	462	10	1	2	232	972	0	0	0	0	44	51	191	33	0	0	0	0	0	130	241	353	446	0	113	2806
2	462	11	1	1	275	876	0	395	95	983	118	48	339	63	0	0	0	0	0	0	0	0	905	102	0	4199
2	462	12	1	1	117	932	0	328	50	1017	215	103	270	93	0	0	0	0	0	0	0	0	796	0	0	3921
team	area	plot	Nº divi	surveyor	walk	start	division	big ground	big bushes	Big forest	land use	influence	soil	slope	det. tree	lich	mount. type	Nat. 2000	mount. Spp	photo	small sp.	small cover	other	assist	wait	TOBS
3	223	1	2	2	87	401	736	963	73	2428	0	684	0	0	0	0	0	0	0	300	1216	1301	662	143	0	8310
3	223	2	1	1	0	679	113	1015	42	1794	111	684	554	90	0	0	0	0	0	0	0	0	380	122	633	6148
3	223	3	1	1	203	481	0	2360	181	881	70	38	692	45	0	0	0	0	0	0	0	0	113	150	337	5551
3	223	7	1	2	229	1832	0	0	0	0	0	0	0	0	0	0	0	0	0	170	245	367	478	0	0	3321
3	223	9	1	2	0	1247	0	0	0	0	0	0	0	0	0	0	0	0	0	0	899	1021	528	368	603	4666
3	223	10	1	1	0	769	0	1284	57	1683	50	240	426	197	0	0	0	0	0	0	0	0	215	0	147	5068
3	223	11	1	1	0	303	0	257	18	1240	20	177	142	102	0	0	0	0	0	452	0	0	782	0	0	4776
3	223	12	1	2	158	1956	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1094	2196	334	0	425	6163
team	area	plot	Nº divi	surveyor	walk	start	division	big ground	big bushes	Big forest	land use	influence	soil	slope	det. tree	lich	mount. type	Nat. 2000	mount. Spp	photo	small sp.	small cover	other	assist	wait	TOBS
4	57	5	1	1	93	268	0	167	98	883	167	0	248	75	0	0	0	0	0	215	0	0	276	12	0	2502
4	57	6	3	1	100	258	729	738	202	1818	95	165	435	90	292	0	0	0	0	88	0	0	426	142	0	5578
4	57	7	1	2	87	1404	0	0	0	0	0	0	0	0	0	0	0	0	0	0	590	637	483	66	0	3267
4	57	8	1	2	137	1172	0	0	0	0	0	0	0	0	0	0	0	0	0	113	521	741	55	162	0	2901
4	57	9	1	1	115	327	0	260	17	1245	82	43	318	0	0	0	0	0	0	183	0	0	80	0	0	2670
4	57	10	1	1	180	1290	0	175	16	232	20	22	254	47	0	0	0	0	0	0	0	0	161	0	0	2397
team	area	plot	Nº divi	surveyor	walk	start	division	big ground	big bushes	Big forest	land use	influence	soil	slope	det. tree	lich	mount. type	Nat. 2000	mount. Spp	photo	small sp.	small cover	other	assist	wait	TOBS
4	82	1		crops	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	82	7		crops	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	82	8	1	2	85	854	0	0	0	0	0	0	0	0	0	0	0	0	0	418	585	700	802	48	0	3492
4	82	9		crops	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	82	10	3	1	202	599	620	527	39	1088	110	336	560	0	0	0	0	0	0	178	0	0	542	0	0	4801
4	82	11		crops	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	82	12		crops	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
				Average 1	***136***	***962***	***88***	***344***	***44***	***470***	***44***	***55***	***215***	***41***	***64***	***0***	***14***	***41***	***3***	***155***	***249***	***320***	***358***	***65***	***81***	***3788***
				Average 2	**122**	**864**	**79**	**310**	**40**	**423**	**40**	**49**	**194**	**37**	**57**	**0**	**13**	**37**	**3**	**140**	**225**	**288**	**322**	**59**	**73**	**3409**

LINES

team	area	line	OBS	N. inters.	w&n	star	wait	walk	intersection	end line	stop	obstacle	re-start	dela	othe	assist	TOTAL
1	585	1	normal	1	47	0	239	417	163	92	0	0	0	0	155	0	1113
1	585	2	normal	0	60	38	184	504	0	215	0	0	0	0	0	0	1001
1	585	3	normal	0	148	135	128	332	0	132	0	0	0	68	0	0	875
1	585	4	normal	0	82	58	325	370	0	100	0	0	0	0	0	0	935
1	585	5	normal	0	130	60	181	415	0	127	0	0	0	0	0	0	913
1	585	6	normal	0	102	57	228	332	0	105	0	0	0	0	0	0	722
1	585	7	normal	1	102	53	112	357	189	138	0	0	0	0	0	0	951
1	585	8	normal	0	180	100	105	763	0	150	0	0	0	0	0	0	1298
1	585	9	normal	0	118	96	146	518	0	30	0	0	0	0	0	0	908
1	585	10	normal	0	155	75	255	425	365	133	0	0	0	0	0	0	1408
1	585	11	normal	0	158	48	196	385	0	104	0	0	0	0	0	0	891
1	585	12	normal	2	73	45	333	487	903	43	0	0	0	0	333	0	2217
team	area	line	OBS	N. inters.	w&n	star	wait	walk	intersection	end line	stop	obstacle	re-start	dela	othe	assist	TOBS
1	602	1	normal	0	0	3	0	698	0	210	0	0	0	0	0	0	911
1	602	2	normal	0	0	65	292	495	0	0	0	0	0	0	0	0	852
1	602	3	normal	1	0	150	62	856	113	103	0	0	0	0	0	0	1284
1	602	4	normal	0	0	115	0	996	0	0	0	0	0	133	0	0	1111
1	602	5	normal	2	0	0	0	738	681	50	0	0	0	0	0	0	1469
1	602	7	normal	0	100	56	0	420	0	51	0	0	0	0	0	0	627
1	602	8	normal	0	0	38	0	491	0	53	0	0	0	0	0	0	582
1	602	9	normal	0	0	76	0	500	0	78	0	0	0	0	0	0	654
1	602	11	normal	0	130	0	179	475	0	163	0	0	0	0	0	0	947
1	602	12	e-map	1	177	0	210	295	282	245	339	863	0	0	0	0	2411
team	area	line	OBS	N. inters.	w&n	star	wait	walk	intersection	end line	stop	obstacle	re-start	dela	othe	assist	TOBS
2	462	1	normal	3	135	82	841	871	482	104	0	0	0	0	0	0	2558
2	462	2	normal	0	0	116	1004	522	0	98	0	0	0	0	0	0	1740
2	462	3	normal	1	0	35	2055	795	22	145	0	0	0	0	0	0	3052
2	462	4	normal	1	185	30	868	406	15	75	0	0	0	0	0	0	1579
2	462	5	normal	0	298	60	1170	501	0	87	0	0	0	0	0	0	2116
2	462	6	normal	2	261	123	1127	594	873	53	0	0	0	0	0	0	3472
2	462	9	normal	2	268	227	978	529	146	105	0	0	0	0	48	0	2301
2	462	10	normal	0	182	79	925	496	0	87	0	0	0	140	0	0	1769
2	462	11	normal	0	270	88	1145	577	0	118	0	0	0	0	0	0	2198
2	462	12	normal	4	335	52	1753	657	729	235	0	0	0	165	0	0	3761
team	area	line	OBS	N. inters.	w&n	star	wait	walk	intersection	end line	stop	obstacle	re-start	dela	othe	assist	TOBS
3	223	1	normal	1	87	48	304	309	340	207	0	0	0	63	0	0	1295
3	223	2	normal	2	105	37	167	577	735	8	0	0	0	0	0	0	1629
3	223	3	normal	3	215	0	466	989	1017	110	0	0	0	0	0	0	2797
3	223	6	s-map	1	0	0	170	45	423	107	0	890	288	0	0	0	1923
3	223	7	e-map	1	113	60	235	97	793	76	0	0	0	0	0	0	1374
3	223	8	s-map	3	0	270	703	165	885	107	123	240	463	178	0	0	2956
3	223	9	normal	1	113	75	356	420	371	125	0	0	0	0	0	0	1460
3	223	10	normal	2	172	0	586	605	982	427	0	0	0	0	0	0	2772
3	223	11	normal	3	202	232	284	480	1329	102	0	0	0	0	0	0	2629
3	223	12	normal	1	295	65	232	440	613	223	0	0	0	0	0	0	1868
team	area	line	OBS	N. inters.	w&n	star	wait	walk	intersection	end line	stop	obstacle	re-start	dela	othe	assist	TOBS
4	57	5	normal	0	130	85	273	277	0	47	0	0	0	0	0	0	812
4	57	6	normal	1	198	50	237	357	293	68	0	0	0	0	0	0	1203
4	57	7	normal	2	168	33	80	509	337	43	0	0	0	0	0	0	1170
4	57	8	normal	2	105	20	331	307	375	25	0	0	0	0	0	0	1163
4	57	9	normal	6	68	0	623	589	1209	7	0	0	0	0	0	0	2496
4	57	10	normal	3	0	0	125	545	665	103	0	0	0	0	0	0	1438
team	area	line	OBS	N. inters.	w&n	star	wait	walk	intersection	end line	stop	obstacle	re-start	dela	othe	assist	TOBS
4	82	1	normal	4	0	0	317	151	1297	288	0	2131	432	0	0	0	4616
4	82	7	s-map	3	0	0	0	0	1808	133	75	4087	328	0	0	0	6431
4	82	8	e-map	0	322	0	0	0	0	12	130	0	0	0	0	0	464
4	82	9	e+s-map	3	442	0	0	352	1230	250	70	1222	117	0	0	0	3683
4	82	10	e-map	1	97	13	0	228	438	0	0	363	0	0	0	0	1139
4	82	11	e+s-map	4	0	0	350	83	870	0	0	0	345	0	125	0	1773
4	82	12	e+s-map	0	0	0	802	402	0	10	167	95	220	0	0	0	1696
			average	**1,23**	**118**	**57**	**394**	**457**	**381**	**107**	**16**	**179**	**39**	**13**	**12**	**0**	**1771**

APPENDIX II

This appendix contains the aerial photos of the areas studied as well as some pictures from photo documentation taken by the field teams. This appendix aims to give to the reader a better view of the areas in this study.

AREA 57

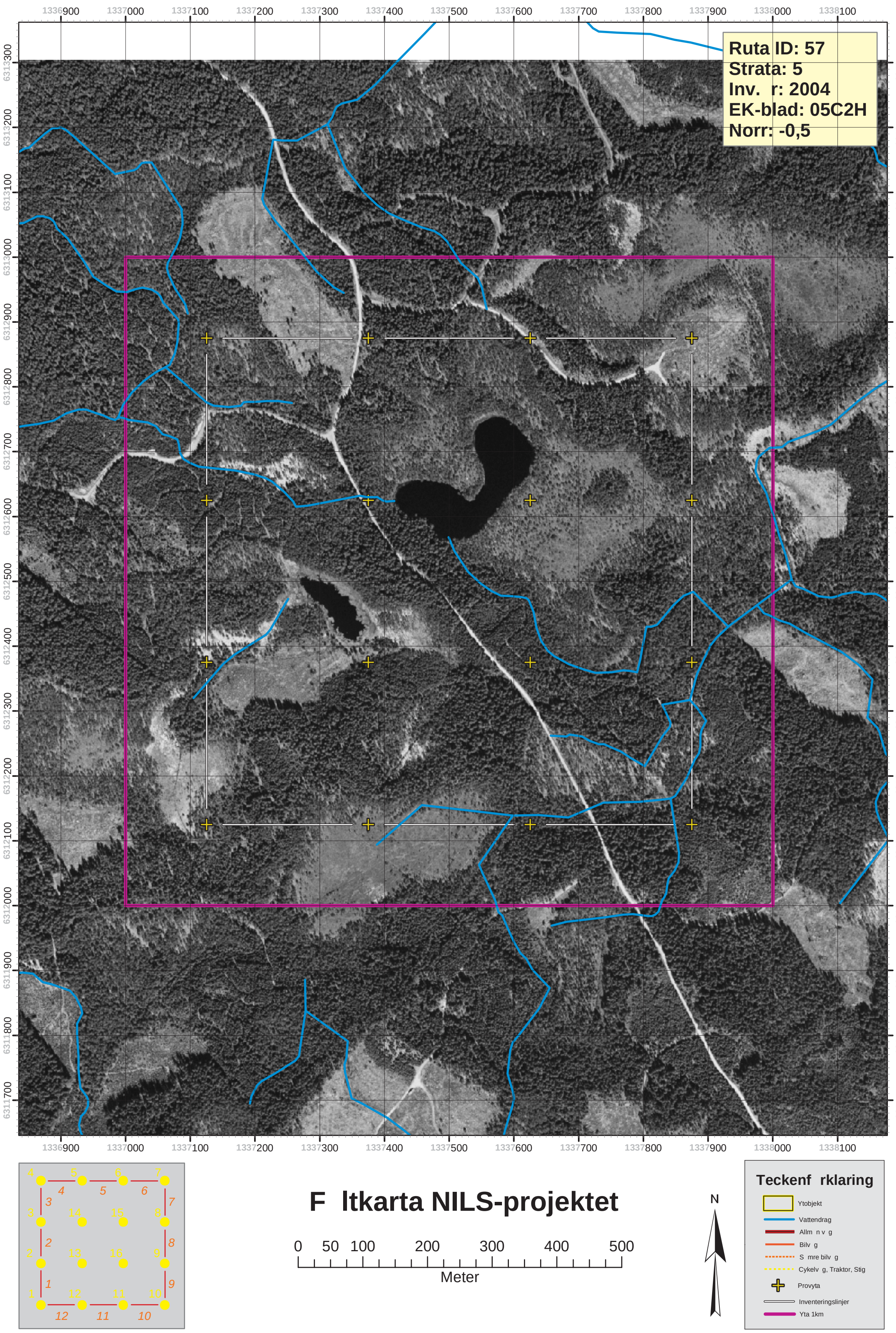

Fig. 1 area 57 (source NILS)

Fig. 2 area 57 (source NILS)

Fig. 3 area 57 (source NILS)

Fig. 4 area 57 (source NILS)

Fig. 5 area 57 (source NILS)

AREA 82

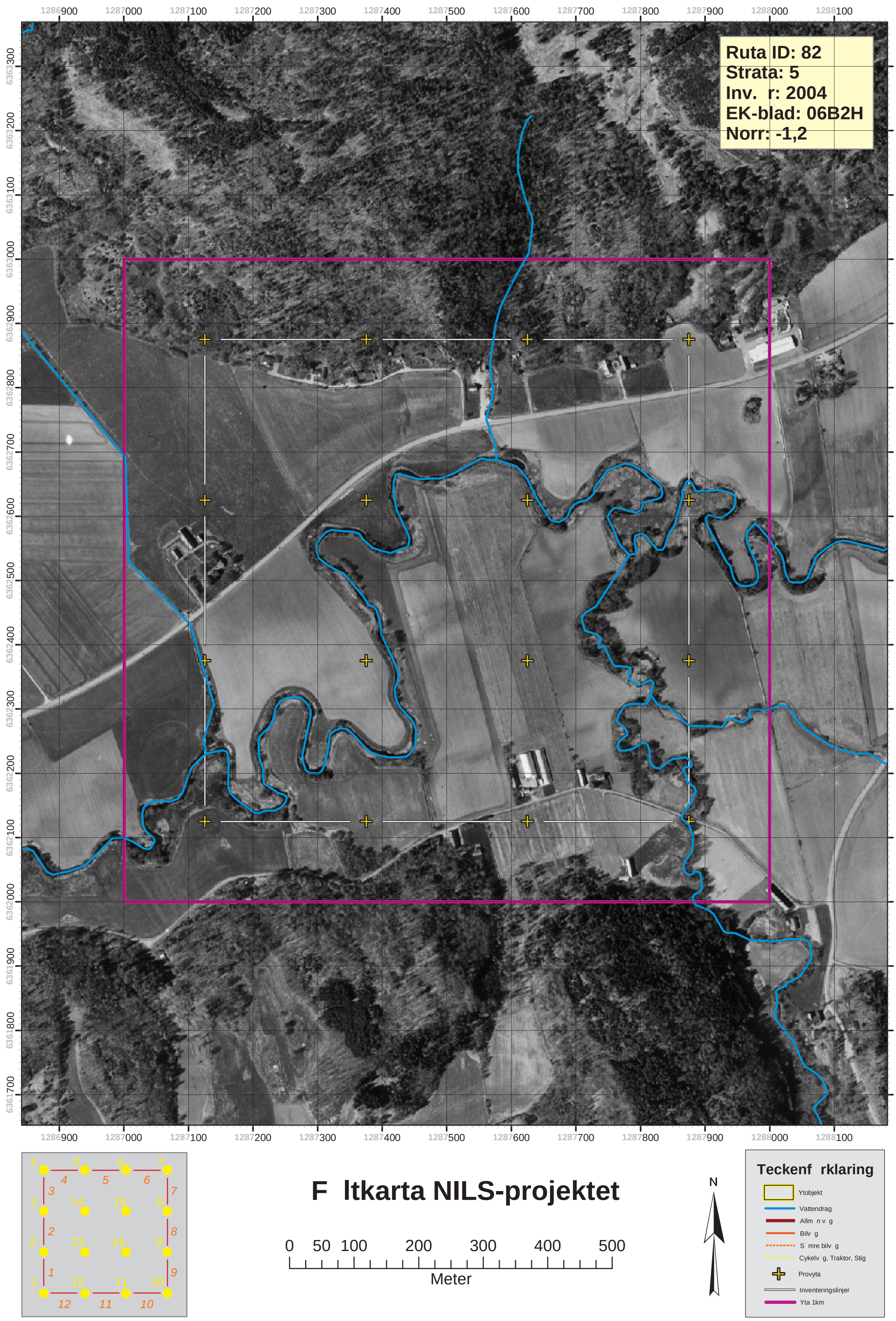

Fig. 6 area 82 (source NILS)

Fig. 7 area 82 (source NILS)

Fig. 8 area 82 (source NILS)

Fig. 9 area 82 (source NILS)

Fig. 10 area 82 (source NILS)

AREA 223

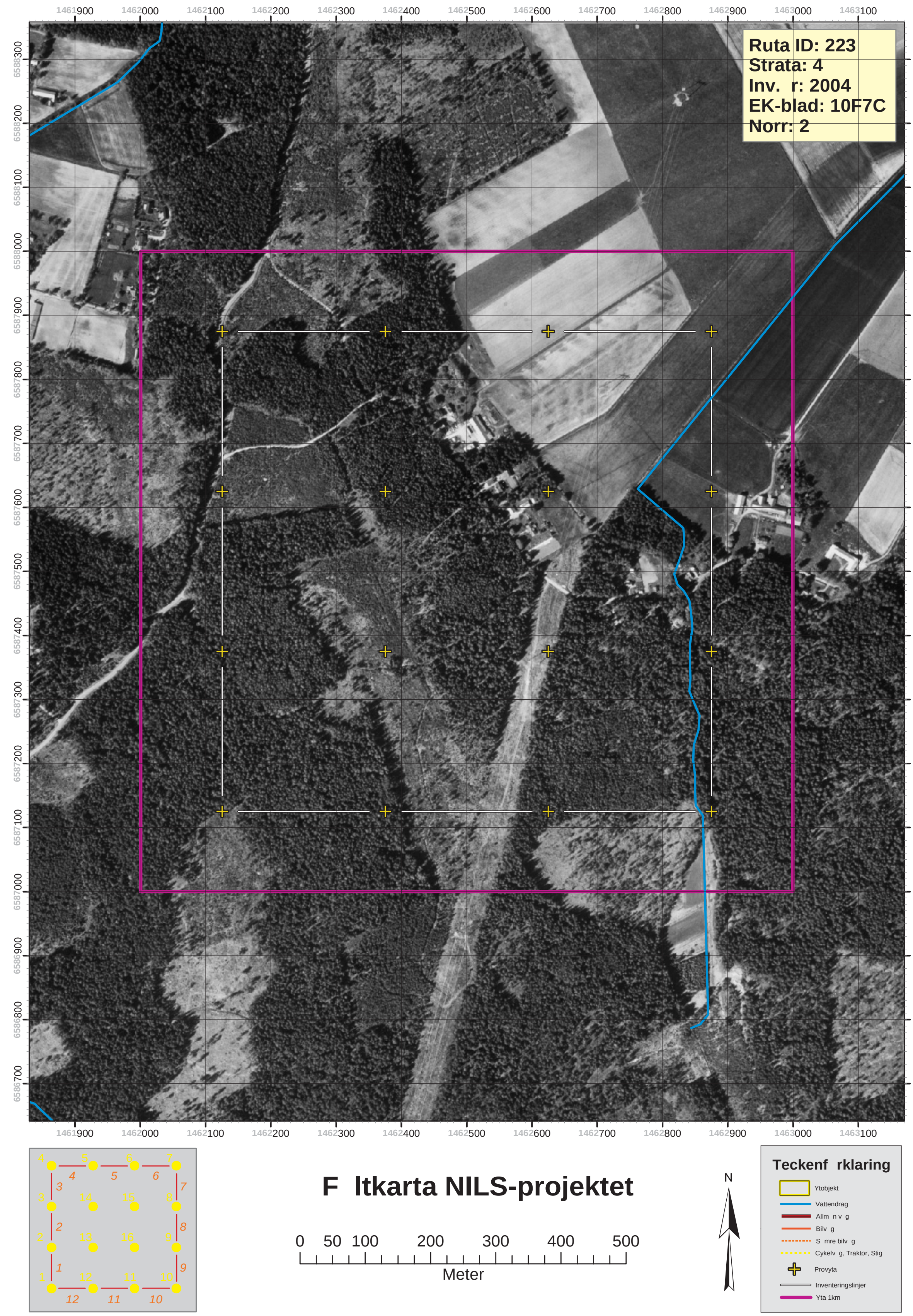

Fig. 11 area 223 (source NILS)

Fig. 12 area 223 (source NILS)

Fig. 13 area 223 (source NILS)

Fig. 14 area 223 (source NILS)

Fig. 15 area 223 (source NILS)

AREA 462

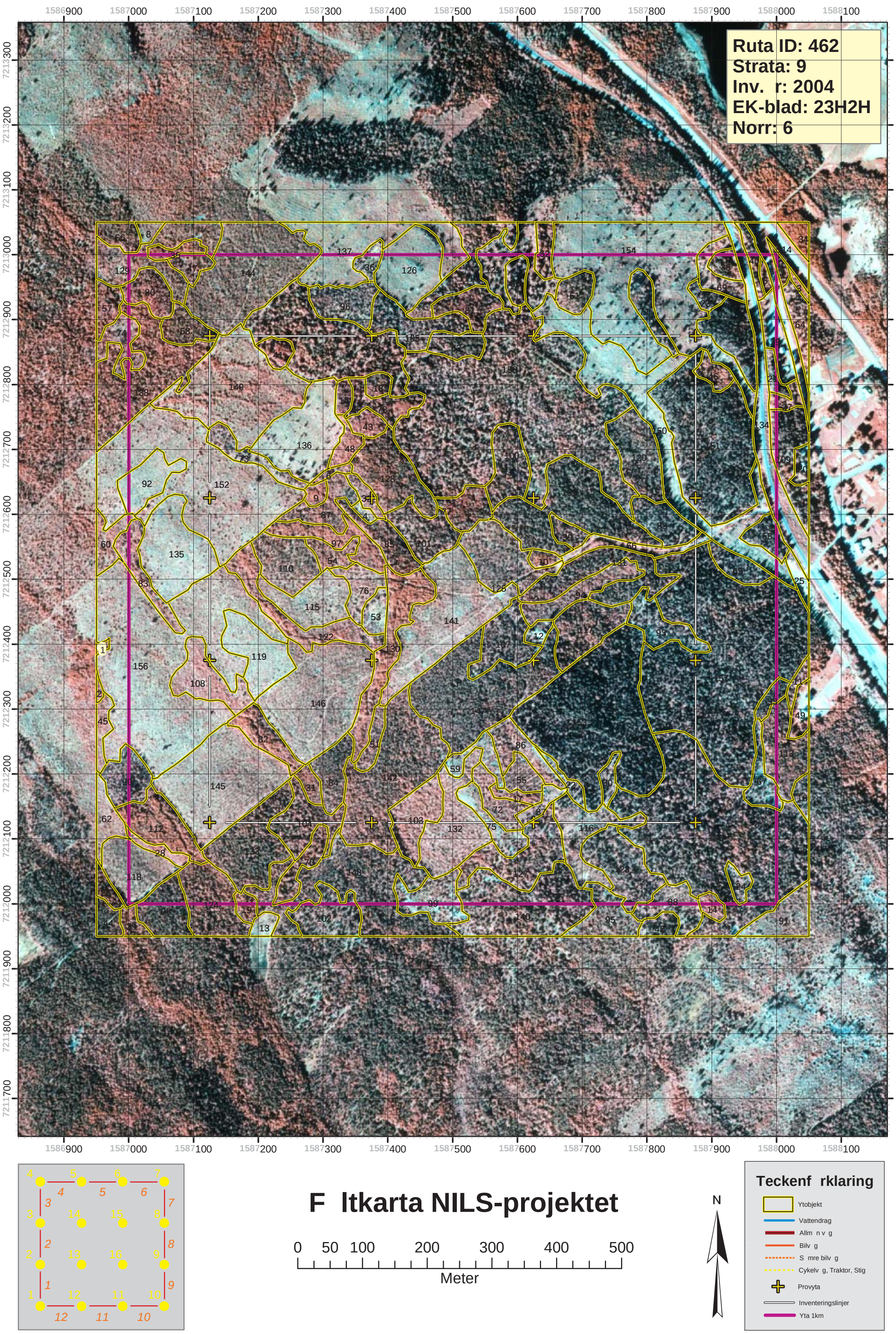

Fig. 16 area 462 (source NILS)

Fig. 17 area 462 (source NILS)

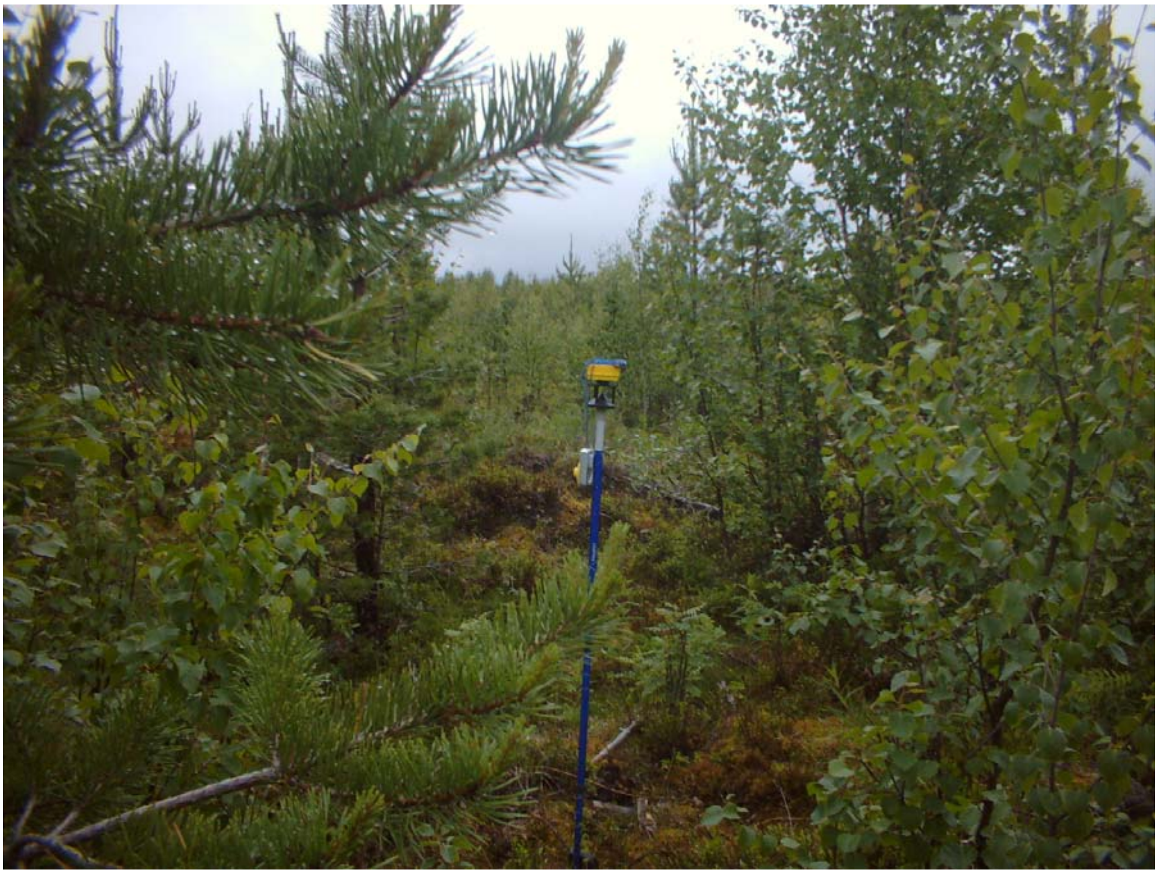

Fig. 18 area 462 (source NILS)

Fig. 19 area 462 (source NILS)

Fig. 20 area 462 (source NILS)

AREA 585

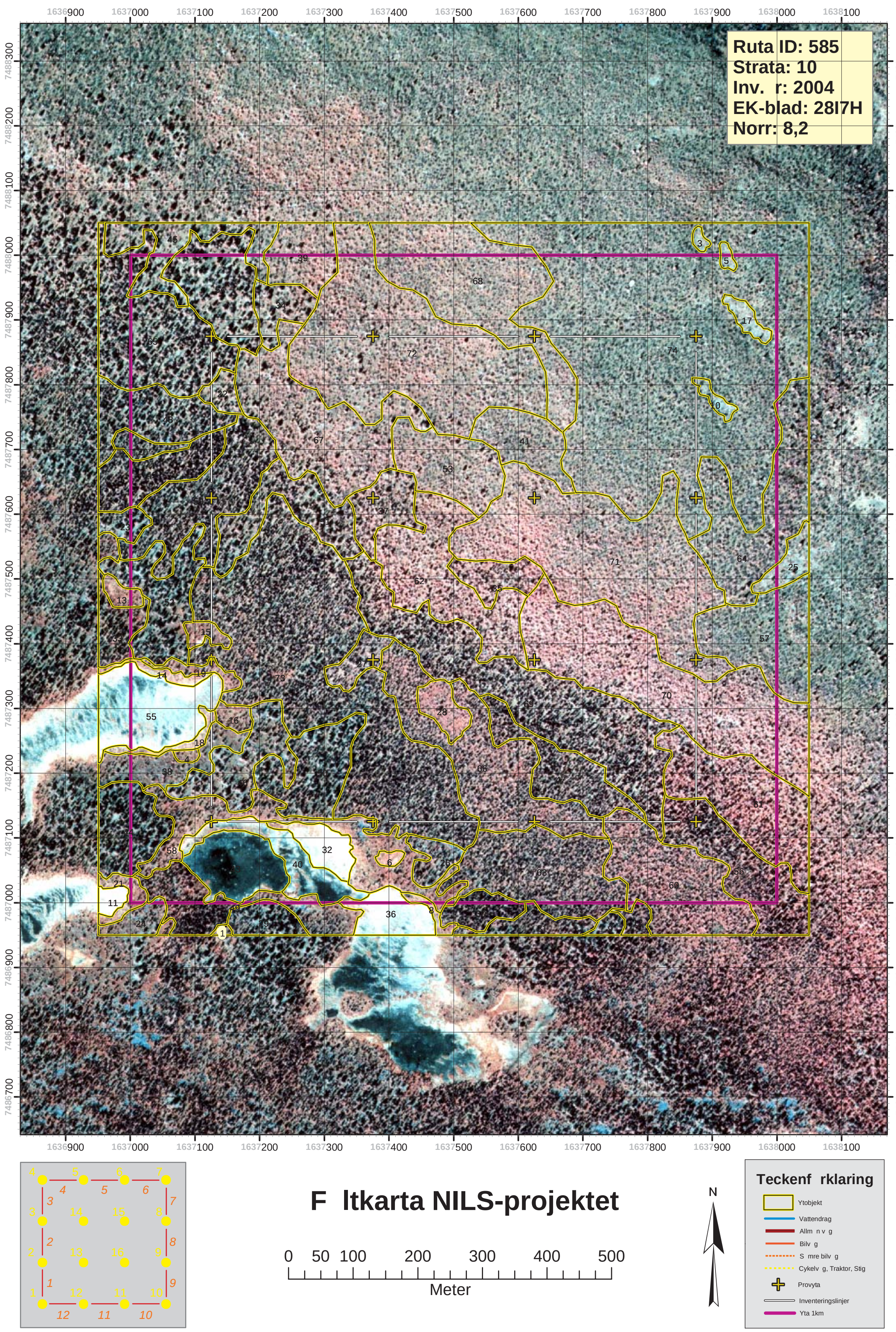

Fig. 21 area 585 (source NILS)

Fig. 22 area 585 (source NILS)

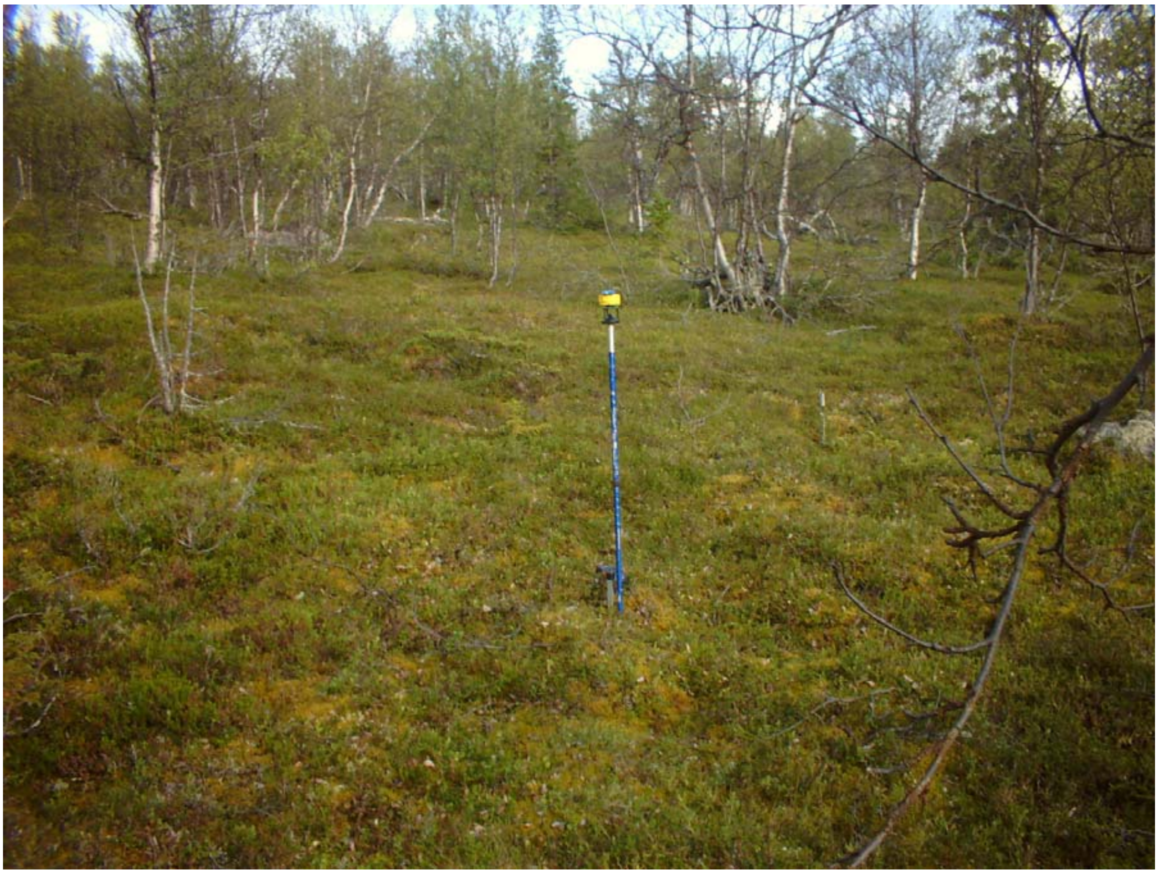

Fig. 23 area 585 (source NILS)

Fig. 24 area 585 (source NILS)

Fig. 25 Area 585 (source NILS)

AREA 602

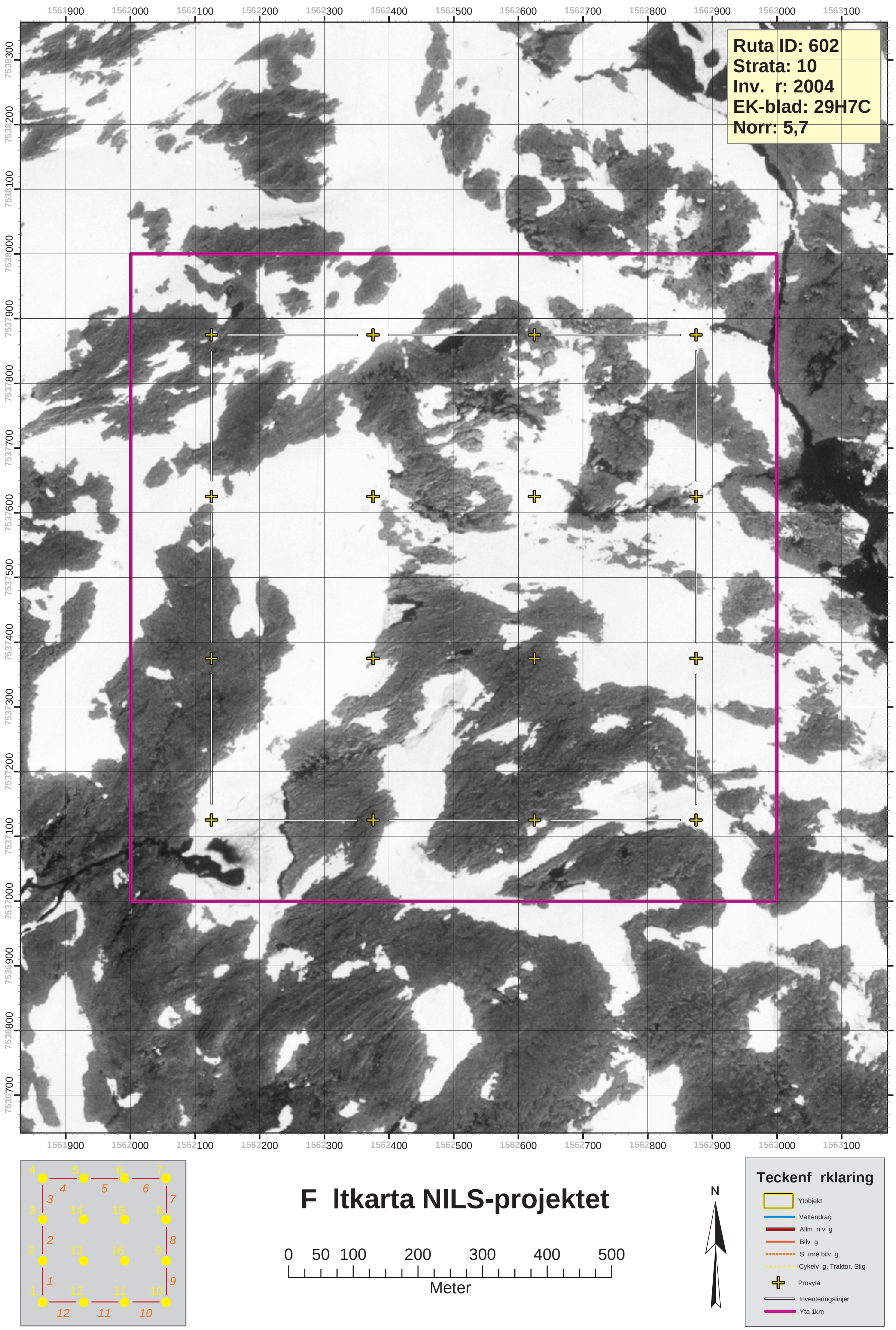

Fig. 26 area 602 (source NILS)

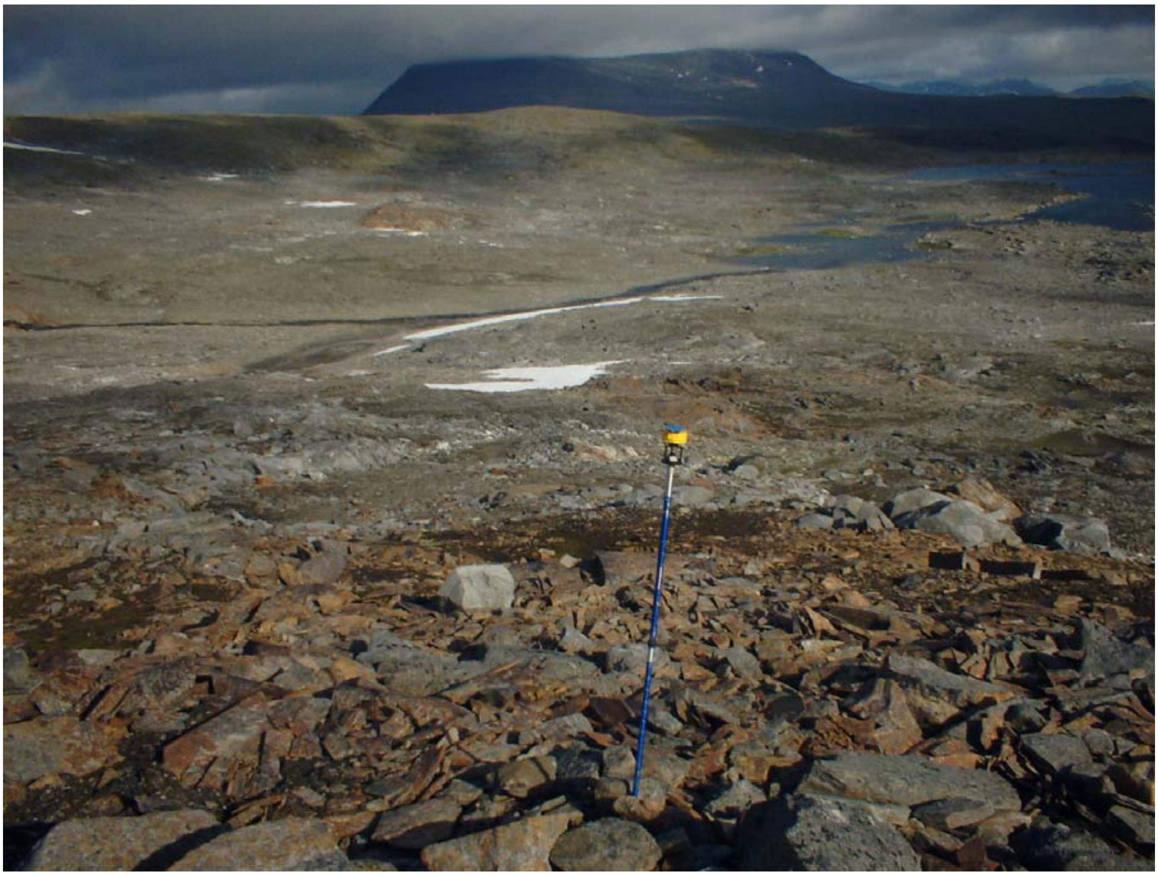

Fig. 27 area 602 (source NILS)

Fig. 28 area 602 (source NILS)

Fig. 29 area 602 (source NILS)

Fig. 30 area 602 (source NILS)

Serien Arbetsrapporter utges i första hand för institutionens eget behov av viss dokumentation. Rapporterna är indelade i följande grupper: Riksskogstaxeringen, Planering och inventering, Biometri, Fjärranalys, Kompendier och undervisningsmaterial, Examensarbeten, Internationellt samt NILS. Författarna svarar själva för rapporternas vetenskapliga innehåll.

Riksskogstaxeringen:

1995	1	Kempe, G.	Hjälpmedel för bestämning av slutenhet i plant- och ungskog. ISRN SLU-SRG-AR--1--SE
	2	Nilsson, P.	Riksskogstaxeringen och Ståndortskarteringen vid regional miljöövervakning. - Metoder för att förbättra upplösningen vid inventering i skogliga avrinningsområden. ISRN SLU-SRG-AR--2--SE
1997	23	Lundström, A., Nilsson, P. & Ståhl, G.	Certifieringens konsekvenser för möjliga uttag av industri- och energived. - En pilotstudie. ISRN SLU-SRG-AR--23--SE
	24	Fridman, J. & Walheim, M.	Död ved i Sverige. - Statistik från Riksskogstaxeringen. ISRN SLU-SRG-AR--24--SE
1998	30	Fridman, J., Kihlblom, D. & Söderberg, U.	Förslag till miljöindexsystem för naturtypen skog. ISRN SLU-SRG-AR--30--SE
	34	Löfgren, P.	Skogsmark, samt träd- och buskmark inom fjällområdet. En skattning av arealer enligt internationella ägoslagsdefinitioner. ISRN SLU-SRG-AR--34--SE
	37	Odell, P. & Ståhl, G.	Vegetationsförändringar i svensk skogsmark mellan 1980- och 90-talet. - En studie grundad på Ståndortskarteringen. ISRN SLU-SRG-AR--37--SE
	38	Lind, T.	Quantifying the area of edges zones in Swedish forest to assess the impact of nature conservation on timber yields. ISRN SLU-SRG-AR--38--SE
1999	50	Ståhl, G., Walheim, M. & Löfgren, P.	Fjällinventering. - En utredning av innehåll och design. ISRN SLU-SRG-AR--50--SE

	52	Fridman, J. & Ståhl, G. (Redaktörer)	Utredningar avseende innehåll och omfattning i en framtida Riksskogstaxering. ISRN SLU-SRG-AR--52--SE
	54	Fridman, J., Holmström, H., Nyström, K., Petersson, H., Ståhl, G. & Wulff, S.	Sveriges skogsmarksarealer enligt internationella ägoslagsdefinitioner. ISRN SLU-SRG-AR--54--SE
	56	Nilsson, P. & Gustafsson, K.	Skogsskötseln vid 90-talets mitt - läge och trender. ISRN SLU-SRG-AR--56--SE
	57	Nilsson, P. & Söderberg, U.	Trender i svensk skogsskötsel - en intervjuundersökning. ISRN SLU-SRG-AR--57--SE
2000	65	Bååth, H., Gällerspång, A., Hallsby, G., Lundström, A., Löfgren, P., Nilsson, M. & Ståhl, G.	Metodik för skattning av lokala skogsbränsleresurser. ISRN SLU-SRG-AR--65--SE
	75	von Segebaden, G.	Komplement till "RIKSTAXEN 75 ÅR". ISRN SLU-SRG-AR--75--SE
2001	86	Lind, T.	Kolinnehåll i skog och mark i Sverige - Baserat på Riksskogstaxeringens data. ISRN SLU-SRG-AR--86--SE
2003	110	Berg Lejon, S.	Studie av mätmetoder vid Riksskogstaxeringens årsringsmätning. ISRN SLU-SRG--AR--110--SE
	116	Ståhl, G.	Critical length sampling for estimating the volume of coarse woody debris. ISRN SLU-SRG-AR--116--SE
	117	Ståhl, G. Blomquist, G. Eriksson, A.	Mögelproblem i samband med risrensning inom Riksskogstaxeringen. ISRN SLU-SRG-AR--117--SE

	118	Ståhl, G. Boström, B. Lindkvist, H. Lindroth, A. Nilsson, J. Olsson, M.	Methodological options for quantifying changes in carbon pools in Swedish forests. ISRN SLU-SRG-AR--118--SE
2004	129	Bååth, H., Eriksson, B., Lundström, A., Lämås, T., Johansson, T., Persson, J A. & Sundquist, S.	Internationellt utbyte och samarbete inom forskning och undervisning i skoglig mätteknik och inventering. -Möjligheter mellan en region i södra USA och SLU. ISRN SLU-SRG-AR--129--SE

Planering och inventering:

1995	3	Homgren, P. & Thuresson, T.	Skoglig planering på amerikanska västkusten - intryck från en studieresa till Oregon, Washington och British Colombia 1-14 augusti 1995. ISRN SLU-SRG-AR--3--SE
	4	Ståhl, G.	The Transect Relascope - An Instrument for the Quantification of Coarse Woody Debris. ISRN SLU-SRG-AR--4--SE
1996	15	van Kerkvoorde, M.	An Sequential approach in mathemtical programming to include spatial aspects of biodiversity in long range forest management planning. ISRN SLU-SRG-AR--15--SE
1997	18	Christoffersson, P. & Jonsson, P.	Avdelningsfri inventering - tillvägagångssätt och tidsåtgång. ISRN SLU-SRG-AR--18--SE
	19	Ståhl, G., Ringvall, A. & Lämås, T.	Guided transect sampling - An outline of the principle. ISRN SLU-SRG-AR--19--SE
	25	Lämås, T. & Ståhl, G.	Skattning av tillstånd och förändringar genom inventeringssimulering - En handledning till programpaketet. ISRN SLU-SRG-AR--25--SE
	26	Lämås, T. & Ståhl, G.	Om detektering av förändringar av populationer i begränsade områden. ISRN SLU-SRG-AR--26--SE
1999	59	Petersson, H.	Biomassafunktioner för trädfraktioner av tall, gran och björk i Sverige. ISRN SLU-SRG-AR--59--SE

	63	Fridman, J., Löfstrand, R. & Roos, S.	Stickprovsvis landskapsövervakning - En förstudie. ISRN SLU-SRG-AR--63--SE
2000	68	Nyström, K.	Funktioner för att skatta höjdtillväxten i ungskog. ISRN SLU-SRG-AR--68--SE
	70	Walheim, M.	Metodutveckling för vegetationsövervakning i fjällen. ISRN SLU-SRG-AR--70--SE
	73	Holm, S. & Lundström, A.	Åtgärdsprioriteter. ISRN SLU-SRG-AR--73--SE
	76	Fridman, J. & Ståhl, G.	Funktioner för naturlig avgång i svensk skog. ISRN SLU-SRG-AR--76--SE
2001	82	Holmström, H.	Averaging Absolute GPS Positionings Made Underneath Different Forest Canopies - A Splendid Example of Bad Timing in Research. ISRN SLU-SRG-AR--82--SE
2002	91	Wilhelmsson, E.	Forest use and it's economic value for inhabitants of Skröven and Hakkas in Norrbotten. ISRN SLU-SRG-AR--91--SE
	93	Lind, T.	Strategier för Östads säteri: Redovisning av planer framtagna under kursen Skoglig planering ur ett företagsperspektiv ht 2001, SLU Umeå. ISRN SLU-SRG-AR--93--SE
	94	Eriksson, O. et. al.	Wood supply from Swedish forests managed according to the FSC-standard. ISRN SLU-SRG-AR--94--SE
2003	108	Paz von Friesen, C.	Inverkan på provytans storlek på regionala skattningar av skogstyper. En studie av konsekvenser för uppföljning av miljömålen. SLU-SRG-AR--108--SE

Biometri:

1997	22	Ali, A. A.	Describing Tree Size Diversity. ISRN SLU-SRG--AR--22--SE
1999	64	Berhe, L.	Spatial continuity in tree diameter distribution. ISRN SLU-SRG--AR--64--SE
2001	88	Ekström, M.	Nonparametric Estimation of the Variance of Sample Means Based on Nonstationary Spatial Data. ISRN SLU-SRG-AR--88--SE

	89	Ekström, M. & Belyaev, Y.	On the Estimation of the Distribution of Sample Means Based on Non-Stationary Spatial Data. ISRN SLU-SRG-AR--89--SE
	90	Ekström, M. & Sjöstedt-de Luna, S.	Estimation of the Variance of Sample Means Based on Nonstationary Spatial Data with Varying Expected Values. ISRN SLU-SRG-AR--90--SE
2002	96	Norström, F.	Forest inventory estimation using remotely sensed data as a stratification tool - a simulation study. ISRN SLU-SRG-AR--96--SE

Fjärranalys:

1997	28	Hagner, O.	Satellitfjärranalys för skogsföretag. ISRN SLU-SRG-AR--28--SE
	29	Hagner, O.	Textur i flygbilder för skattningar av beståndsegenskaper. ISRN SLU-SRG-AR--29--SE
1998	32	Dahlberg, U., Bergstedt, J. & Pettersson, A.	Fältinstruktion för och erfarenheter från vegetationsinventering i Abisko, sommaren 1997. ISRN SLU-SRG-AR--32--SE
	43	Wallerman, J.	Brattåkerinventeringen. ISRN SLU-SRG-AR--43--SE
1999	51	Holmgren, J., Wallerman, J. & Olsson, H.	Plot-level Stem Volume Estimation and Tree Species Discrimination with Casi Remote Sensing. ISRN SLU-SRG-AR--51--SE
	53	Reese, H. & Nilsson, M.	Using Landsat TM and NFI data to estimate wood volume, tree biomass and stand age in Dalarna. ISRN SLU-SRG-AR--53--SE
2000	66	Löfstrand, R., Reese, H. & Olsson, H.	Remote sensing aided Monitoring of Nontimber Forest Resources - A literature survey. ISRN SLU-SRG-AR--66--SE
	69	Tingelöf, U. & Nilsson, M.	Kartering av hyggeskanter i pankromatiska SPOT-bilder. ISRN SLU-SRG-AR--69--SE
	79	Reese, H. & Nilsson, M.	Wood volume estimations for Älvsbyn Kommun using SPOT satellite data and NFI plots. ISRN SLU-SRG-AR--79--SE

2003	106	Olofsson, K.	TreeD version 0.8. An Image Processing Application for Single Tree Detection. ISRN SLU-SRG-AR--106-SE
2003	112	Olsson, H. Granqvist Pahlen, T. Reese, H. Hyyppä, J. Naesset, E.	Proceedings of the ScandLaser Scientific Workshop on Airborne Laser Scanning of Forests. September 3 & 4, 2003. Umeå, Sweden. ISRN SLU-SRG-AR--112--SE
	114	Manterola Matxain, I.	Computer Visualization of forest development scenarios in Bäcksjön estate. ISRN SLU-SRG-AR--114--SE
2004	122	Dettki, H. & Wallerman, J.	Skoglig GIS- och fjärranalysundervisning inom Jägmästar- och Skogsvetarprogrammet på SLU. - En behovsanalys. ISRN SLU-SRG-AR--122--SE
2005	136	Bohlin, J.	Visualisering av skog och skogslandskap -erfarenheter från användning av Visual Nature Studio 2 och OnyxTree. ISRN SLU-SRG-AR--136--SE

Kompendier och undervisningsmaterial:

1996	14	Holm, S. & Thuresson, T. samt jägm. studenter kurs 92/96	En analys av skogstillståndet samt några alternativa avverkningsberäkningar för en del av Östads säteri. ISRN SLU-SRG-AR--14--SE
1997	21	Holm, S. & Thuresson, T. samt jägm.studenter kurs 93/97.	En analys av skogstillsåndet samt några alternativa avverkningsberäkningar för en stor del av Östads säteri. ISRN SLU-SRG-AR--21--SE
1998	42	Holm, S. & Lämås, T. samt jägm.studenter kurs 94/98.	An analysis of the state of the forest and of some management alternatives for the Östad estate. ISRN SLU-SRG-AR--42--SE

1999	58	Holm, S. & Lämås, T. samt studenter vid Sveriges lantbruksuniversitet.	En analys av skogstillsåndet samt några alternativa avverkningsberäkningar för Östads säteri. ISRN SLU-SRG-AR--58--SE
2001	87	Eriksson, O. (Ed.)	Strategier för Östads säteri: Redovisning av planer framtagna under kursen Skoglig planering ur ett företagsperspektiv HT2000, SLU Umeå. ISRN SLU-SRG-AR--87--SE
2003	115	Lindh, T.	Strategier för Östads Säteri: Redovisning av planer framtagna under kursen Skoglig Planering ur ett företagsperspektiv HT 2002, SLU Umeå. SLU-SRG--AR--115--SE

Examensarbeten:

1995	5	Törnquist, K.	Ekologisk landskapsplanering i svenskt skogsbruk - hur började det? ISRN SLU-SRG-AR--5--SE
1996	6	Persson, S. & Segner, U.	Aspekter kring datakvalitén̈s betydelse för den kortsiktiga planeringen. ISRN SLU-SRG--AR--6--SE
	7	Henriksson, L.	The thinning quotient - a relevant description of a thinning? Gallringskvot - en tillförlitlig beskrivning av en gallring? ISRN SLU-SRG-AR--7--SE
	8	Ranvald, C.	Sortimentsinriktad avverkning. ISRN SLU-SRG-AR--8--SE
	9	Olofsson, C.	Mångbruk i ett landskapsperspektiv - En fallstudie på MoDo Skog AB, Örnsköldsviks förvaltning. ISRN SLU-SRG-AR--9--SE
	10	Andersson, H.	Taper curve functions and quality estimation for Common Oak (Quercus Robur L.) in Sweden. ISRN SLU-SRG-AR--10--SE
	11	Djurberg, H.	Den skogliga informationens roll i ett kundanpassat virkesflöde. - En bakgrundsstudie samt simulering av inventeringsmetoders inverkan på noggrannhet i leveransprognoser till sågverk. ISRN SLU-SRG-AR--11--SE
	12	Bredberg, J.	Skattning av ålder och andra beståndsvariabler - en fallstudie baserad på MoDo:s indelningsrutiner. ISRN SLU-SRG-AR--12--SE

	13	Gunnarsson, F.	On the potential of Kriging for forest management planning. ISRN SLU-SRG-AR--13--SE
	16	Tormalm, K.	Implementering av FSC-certifiering av mindre enskilda markägares skogsbruk. ISRN SLU-SRG-AR--16--SE
1997	17	Engberg, M.	Naturvärden i skog lämnad vid slutavverkning. - En inventering av upp till 35 år gamla föryngringsytor på Sundsvalls arbetsområde, SCA. ISRN SLU-SRG-AR--17--SE
	20	Cedervind, J.	GPS under krontak i skog. ISRN SLU-SRG-AR--20--SE
	27	Karlsson, A.	En studie av tre inventeringsmetoder i slutavverkningsbestånd. ISRN SLU-SRG-AR--27--SE
1998	31	Bendz, J.	SÖDRAs gröna skogsbruksplaner. En uppföljning relaterad till SÖDRAs miljömål, FSC's kriterier och svensk skogspolitik. ISRN SLU-SRG-AR--31--SE
	33	Jonsson, Ö.	Trädskikt och ståndortsförhållanden i strandskog. - En studie av tre bäckar i Västerbotten. ISRN SLU-SRG-AR--33--SE
	35	Claesson, S.	Thinning response functions for single trees of Common oak (Quercus Robur L.). ISRN SLU-SRG-AR--35--SE
	36	Lindskog, M.	New legal minimum ages for final felling. Consequenses and forest owner attitudes in the county of Västerbotten. ISRN SLU-SRG-AR--36--SE
	40	Persson, M.	Skogsmarkindelningen i gröna och blå kartan - en utvärdering med hjälp av Riksskogstaxeringens provytor. ISRN SLU-SRG-AR--40--SE
	41	Eriksson, M.	Markbaserade sensorer för insamling av skogliga data - en förstudie. ISRN SLU-SRG-AR--41--SE
	45	Gessler, C.	Impedimentens potentiella betydelse för biologisk mångfald. - En studie av myr- och bergimpediment i ett skogslandskap i Västerbotten. ISRN SLU-SRG-AR--45--SE
	46	Gustafsson, K.	Långsiktsplanering med geografiska hänsyn - en studie på Bräcke arbetsområde, SCA Forest and Timber. ISRN SLU-SRG-AR--46--SE

	47	Holmgren, J.	Estimating Wood Volume and Basal Area in Forest Compartments by Combining Satellite Image Field Data. ISRN SLU-SRG-AR--47--SE
	49	Härdelin, S.	Framtida förekomst och rumslig fördelning av gammal skog. - En fallstudie på ett landskap i Bräcke arbetsområde. ISRN SLU-SRG-AR--49--SE
1999	55	Imamovic, D.	Simuleringsstudie av produktionskonekvenser med olika miljömål. ISRN SLU-SRG-AR--55--SE
	62	Fridh, L.	Utbytesprognoser av rotstående skog. ISRN SLU-SRG-AR--62--SE
2000	67	Jonsson, T.	Differentiell GPS-mätning av punkter i skog. Point-accuracy for differential GPS under a forest canaopy. ISRN SLU-SRG-AR--67--SE
	71	Lundberg, N.	Kalibrering av den multivariata variabeln trädslagsfördelning. ISRN SLU-SRG-AR--71--SE
	72	Skoog, E.	Leveransprecision och ledtid - två nyckeltal för styrning av virkesflödet. ISRN SLU-SRG-AR--72--SE
	74	Johansson, L.	Rotröta i Sverige enligt Riksskogstaxeringen. - En beskrivning och modellering av rötförekomst hos gran, tall och björk. ISRN SLU-SRG-AR--74--SE
	77	Nordh, M.	Modellstudie av potentialen för renbete anpassat till kommande slutavverkningar. ISRN SLU-SRG-AR--77--SE
	78	Eriksson, D.	Spatial Modeling of Nature Conservation Variables useful in Forestry Planning. ISRN SLU-SRG-AR--78--SE
	81	Fredberg, K.	Landskapsanalys med GIS och ett skogligt planeringssystem. ISRN SLU-SRG-AR--81--SE
2001	83	Lindroos, O.	Underlag för skogligt länsprogram Gotland. ISRN SLU-SRG-AR--83-SE

	84	Dahl, M.	Satellitbildsbaserade skattningar av skogsområden med röjningsbehov (Satellite image based estimations of forest areas with cleaning requirements). ISRN SLU-SRG-AR--84--SE
	85	Staland, J.	Styrning av kundanpassade timmerflöden - Inverkan av traktbankens storlek och utbytesprognosens tillförlitlighet. ISRN SLU-SRG-AR--85--SE
2002	92	Bodenhem, J.	Tillämpning av olika fjärranalysmetoder för urvalsförfarandet av ungskogsbestånd inom den enkla älgbetesinventeringen (ÄBIN). ISRN SLU-SRG-AR--92--SE
	95	Sundquist, S.	Utveckling av ett mått på produktionsslutenhet för Riksskogstaxeringen. ISRN SLU-SRG-AR--95--SE
	98	Söderholm, J.	De svenska skogsbolagens system för skoglig planering. ISRN SLU-SRG-AR--98--SE
	99	Nordin, D.	Fastighetsgränser. Del 1. Fallstudie av fastighetsgränsers lägesnoggrannhet på fastighetskartan. ISRN SLU-SRG-AR--99--SE
	100	Nordin, D.	Fastighetsgränser. Del 2. Instruktion för gränsvård. ISRN SLU-SRG-AR--100--SE
	101	Nordbrandt, A.	Analyser med Indelningspaketet av privata skogsfastigheter inom Norra Skogsägarnas verksamhetsområde. ISRN SLU-SRG-AR--101--SE
2003	102	Wallin, M.	Satellitbildsanalys av gremmeniellaskador med skogsvårdsorganisationens system. ISRN SLU-SRG-AR--102--SE
	103	Hamilton, A.	Effektivare samråd mellan rennäring och skogsbruk - förbättrad dialog via ett utvecklat samrådsförfarande. ISRN SLU-SRG-AR--103--SE
	104	Hajek, F.	Mapping of Intact Forest Landscapes in Sweden according to Global Forest Watch methdology. ISRN SLU-SRG-AR--104--SE
	105	Anerud, E.	Kalibrering av ståndortsindex i beståndsregister - en studie åt Holmen Skog AB. ISRN SLU-SRG-AR--105--SE

	107	Pettersson, L.	Skördarnavigering kring skyddsvärda objekt med GPS-stöd. SLU-SRG-AR--107--SE
	109	Östberg, P-A.	Försök med subjektiva metoder för datainsamling och analys av hur fel i data påverkar åtgärdsförslagen. SLU-SRG-AR--109--SE
	111	Hansson, J.	Vad tycker bilister om vägnära skogar - två enkätstudier. SLU-SRG-AR--111--SE
	113	Eriksson, P.	Renskötseln i Skandinavien. Förutsättningar för sambruk och konflikthantering. SLU-SRG-AR--113--SE
	119	Björklund, E.	Medlemmarnas syn på Skogsägarna Norrskog. ISRN SLU-SRG--AR--119--SE
2004	120	Fogdestam, Niklas	Skogsägarna Norrskog:s slutavverkningar och PEFC-kraven - fältinventering och intervjuer. ISRN SLU-SRG--AR--120--SE
	121	Petersson, T	Egenskaper som påverkar hänsynsarealer och drivningsförhållanden på föryngringsavverkningstrakter -En studie över framtida förändringar inom Sveaskog. ISRN SLU-SRG--AR--121--SE
	123	Mattsson, M	Markägare i Stockholms län och deras inställning till biodiversitet och skydd av mark. ISRN SLU-SRG--AR--123--SE
	125	Eriksson, M.	Skoglig planering och ajourhållning med SkogsGIS - En utvärdering av SCA:s nya GIS-verktyg med avseende på dess introduktion, användning och utvecklingspotential. ISRN SLU-SRG--AR--125--SE
	130	Olmårs, P.	Metrias vegetationsdatabas i skogsbruket - En GIS-studie. ISRN SLU-SRG--AR--130--SE
	131	Nilsson, M.	Skogsmarksutnyttjande på Älvdalens kronopark före 1870. En kulturhistorisk beskrivning och analys. ISRN SLU-SRG--AR--131--SE
2005	133	Bjerner, J.	Betydelsen av felaktig information i traktbanken -Inverkan på virkesleveranser samt tidsåtgång och kostnad vid avverkningar. ISRN SLU-SRG--AR--133--SE

	138	Kempainen, E.	Ett kalkylstöd för ekonomiska analyser av avverkningsåtgärder på beståndsnivå. A calculation support program for economic analysis of cutting actions on stand level. ISRN SLU-SRG--AR--138--SE
	140	González, J.D.D.	A time study and description of the work methods for the field work in the National Inventory of Landscapes in Sweden. ISRN SLU-SRG--AR--140--SE

Internationellt:

1998	39	Sandewall, M., Ohlsson, B. & Sandewall, R.K.	People's options of forest land use - a research study of land use dynamics and socio-economic conditions in a historical perspective in the Upper Nam Water Catchment Area, Lao PDR. ISRN SLU-SRG-AR--39--SE
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