SLU

Wood Supply From Swedish Forests Managed According to the FSC-standard

Ljusk Ola Eriksson
Ola Sallnäs
Göran Ståhl
Dzemal Imamovic
Hans Petersson

Arbetsrapport 94 2002
Working Paper 94 2002

SWEDISH UNIVERSITY OF
AGRICULTURAL SCIENCES (SLU)
Department of Forest Resource
Management and Geomatics
S-901 83 UMEÅ
Phone: 090-786 58 25 Fax: 090-14 19 15, 77 81 16

ISSN 1401-1204
ISRN SLU-SRG-AR--94 --SE

Preface

This work has been conducted with researchers from two departments at SLU, the Department of Forest Resource Management and the Southern Swedish Forest Research Centre. Dzemal Imamovic contributed to the database in terms of economic and other data and tested sub-models of the system. Hans Pettersson developed the models for diameter and species composition. Ola Eriksson, Ola Sallnäs and Göran Ståhl are responsible for the analysis of the data and writing of the report. The project team also wish to express their gratitude to personnel at the National Forest Inventory for their preparation of the NFI data set.

The project was financed with a grant from the Trygger foundation.

Table of Contents

Introduction 4
Methods 5
    Basic model concepts 5
    Forest model and solution procedure.. 6
Data.. 7
    Regions 7
    Scenarios.. 7
    Economic data 10
Results 11
Discussion.. 14
Conclusions 16
References 17

Introduction

In 1998, the Swedish standard for forest certification according to FSC's principles and criteria was approved (Anon. 1998). During a short period following this approval, all major forest companies in Sweden adopted the standard and modified their management practices. The overall aim of the standard is to outline management principles that maintain the ecosystem productivity and biodiversity, secure local people's livelihood, and promote long-term valuable wood-production. In particular, the standard comprises many detailed regulations regarding how forests should be managed. For example, 5 percent of forest areas should be set aside for free development or be managed to promote biological values, certain areas must be managed to promote deciduous forests, boundary zones to streams, lakes, and non-productive land should be left, as should also a certain minimum number of trees (10 ha^{-1}) during harvesting operations (Anon. 1998).

Compared to management practices of most companies before adoption of the FSC standard, the new management regimes imply lower levels of potential harvests. Some analyses have been made to quantify the effects on the harvesting levels of the new management (e.g., Lundström et al. 1997, Anon. 2000). In these studies, the range of harvesting reduction due to the FSC standard has been found to be in the order 10 to 20 percent. Similar results are presented by Verkaik and Nabuurs (2000) in a study of the consequences of adopting "nature-orientated" management in Scandinavian forests. It should be noted that in the latter study no attempts were made to follow the FSC standard specifically.

The long-term sustainable harvesting levels in Sweden, before the adoption of the FSC criteria, have been assessed to be slightly more than 100 mill. m^3 per year (Anon. 2000). The annual cutting levels during the last decade have been about 70-75 mill. m^3 per year. There are several reasons for the relatively large difference between the two figures. Firstly, many forests in Sweden are still comparably young, and thus not mature for final felling. Secondly, we are here dealing with different concepts. The level around 100 mill. m^3 is what, from a biological point of view, would be possible to sustainably take out from the forests – it is reflecting a potential. In this calculation no considerations to restrictions of technical, social or economic kind are taken. The factual figure of 70-75 mill. m^3 is reflecting the real supply of wood, given the economic setting and restrictions on forestry of different kinds.

In most of the above studies of the effect of FSC's standard on the harvesting levels, the modelling approach has been to let the management activities be controlled by a set of rules formulated to mimic certain forest management practices. These rules are followed, even if a deeper analysis (which is typically not made) for some forestry activities would imply negative results from an economical point of view. Together this implies that these studies are dealing with the "potential" discussed above.

A different approach is to put forestry into an economical framework, letting the activities largely be controlled by economical considerations. The result of such an analysis most likely would be a different round-wood supply, leading to lower harvesting levels as compared to the levels that correspond to the biological potential. It can be argued that this kind of analysis in a better way would be able to assess the actual consequences on the harvesting levels of new demands on forestry, e.g. those caused by FSC certification.

The objective of this study was to analyse the implications of the FSC standard on the supply of round-wood in Sweden. This is done with respect to both the effects on current supply relationships and the long-term harvest level. Two different assumptions about the rigor of the FSC-standard are analysed. These two scenarios are contrasted to a modified version of the environmental restrictions of the recent SKA study (Anon. 2000) which is used as a baseline case. The constraints are less restrictive than in the SKA study and are intended to reflect forest management under the current Forestry Act, though with no adherence to the particular stipulations of the FSC standard. Furthermore, an extreme case with no environmental considerations is included in order to assess the maximum economic potential.

The different levels of environmental objectives form the basis for four scenarios. The scenarios differ with respect to the amount area that can be used for production and how much is allocated for modified management and into reserves. Except for the distribution of the forest area on permissible management, the economic and other conditions remain the same. The analysis was performed with a method for modelling the forest and the forest manager decisions developed by Sallnäs and Eriksson (1989). The method derives economically optimal harvesting regimes for all types of forests given certain assumptions regarding prices and costs.

Methods

Basic model concepts

The results of this report rests on solutions to a forest management problem that pertains to the forest owner. The outcome of different projections is the aggregate of the owners actions. Here, some basic assumptions behind the management problem will be given before the different models and solution procedures are presented in the next section.

The forest owner is assumed to maximize monetary profits, i.e. the net present value of the forest holding. Three assumptions will underpin the representation of the management problem in the model. First, when calculating what treatment is optimal for a certain piece of land at a certain point in time, it is assumed that the owner expects the current price level to persist throughout time, an assumption that should be consistent with efficient timber markets. Second, we assume that all forest owners encounter the same economic conditions relevant for their forest management decisions. This means the net revenue of a treatment, whether in establishment or harvesting, of a certain piece of land should be the same irrespective of ownership category. From the assumption also follows that financial markets must be efficient as all owners would share the same interest rate. Third, it is assumed that decisions are not affected by the state of the forest holding, i.e. forest wide constraints bear no importance for what treatments are selected.

Here a stage structured Markov model is used. Together with this model concept, the three assumptions will have the following implications for the construction of a profit maximising model of the Swedish forest owners. The third assumption implies that the problem is separable; given a set of prices, an optimal solution to the forest management problem can be derived by selecting an optimal treatment for each piece of land separately (Johansson Löfgren). With a Markov model each state of the model can be inspected one by one, and still optimality is preserved. The second assumption, together with the third, allows all forest belonging to the same forest state to be treated in the same (optimal) way.

The first assumption implies that, for a given price level, the optimal decision will be the same for forest in a given state regardless of when it is made since historic prices are irrelevant. One may note that, while the second and third assumptions are more technical in nature and primarily serves the purpose of simplifying the administration and running of the model, the constant price assumption could have fundamental consequences for the kind of results that are derived (Sallnäs and Eriksson 1989).

Forest model and solution procedure

The solution procedures are built on the dynamics of the forest model (Sallnäs 1990). The Markov forest model is given by

$$x_j^{t+1} = \sum_{ik} y_{ik}^t \cdot T_{ijk} \qquad \forall\ j \in I \qquad (1)$$

$$x_i^t = \sum_k y_{ik}^t \qquad \forall\ i \in I \qquad (2)$$

where x_i^t is the area residing in state i in period t, y_{ik}^t is the area in state i subject to treatment k in period t, and T_{ijk} is the probability for an area residing in state i in period t to be found in state j in period $t+1$ when subject to treatment k. Thus, (1) gives the transition of areas between states between period t and $t+1$ as a function of the treatment of the forest and (2) ensures that the whole forest area is allocated a treatment (no action is also regarded as a treatment). The total set of states is I and the projection period consists of five years.

The forest area is distributed on three broad treatment groups depending on what kind of treatments are allowed. The amount that belongs to each group depends on what scenario is analysed (see Scenarios in the next section). Within each treatment group, the forest area is differentiated on established forest (forest with an average height above six metres) and young forest (including bare land). The state space of established forest is defined by geographical region, owner category, site quality, species composition, age, volume, thinning state (thinned or not thinned the previous period, respectively) and comprises a total of 51,840 states. The state space of young forest is defined by geographical region, owner category, site quality and age and consists of 384 states.

The forest management problem in period t consists of maximizing the net present value, i.e.

$$Max \quad \sum_{ik} \left(n_{ik} + d \cdot \sum_{j \in I} T_{ijk} \cdot e_j \right) \cdot y_{ik}^t \qquad (3)$$

subject to

$$x_i^t = \sum_k y_{ik}^t \qquad \forall\ i \in I \qquad (4)$$

$$y_{ik}^t \in K_i \qquad \forall\, i \in I \qquad (5)$$

where n_{ik} is the net revenue of treatment k in forest belonging to state i, d is the one-period discount factor and e_i is the expected value of forest and land of state i. Equation (4) is equivalent to (2) and (5) ensures that the treatment of each state i belongs to the set of permissible treatments K_i. The expected value of each class i, e_i, is derived by solving the set of equations

$$e_i = \max_{k \in K_i} \left\{ n_{ik} + \sum_j d \cdot T_{ijk} \cdot e_i \right\} \qquad \forall\, i \in I \qquad (6)$$

Thus, the expected values are derived under an infinite time horizon assuming optimal treatments. System (6) is here solved with a successive approximation algorithm (Denardo 1982).

The first step in making an analysis with the model is to distribute the forest area on the three different treatment groups depending on the scenario that should be analysed. Then, for each treatment group, the following steps are completed:

1. Set the economic conditions in terms of, for instance, discount rate and timber prices and compute net revenues, n_{ik}, and expected prices of forest land, e_i.
2. Compute the area residing in each state, i.e. get a description of the initial state of the forest in terms of the number of hectares in each state of state of the Markov model, x_i^1.
3. Make a projection for a number of five-year periods by (i) solving the management problem for period 1 with equations (3)-(5), (ii) projecting the forest into period 2 with equation (1), and then repeating the steps (i) and (ii) for the number of periods the projection should encompass.

Once the projection has been made for all treatment groups, the result is consolidated to cover the whole forest area and presented. By varying the amount of area distributed on different treatment groups or by changing the economic parameters, different developments can be created.

Data

Regions

Calculations are done for the four balance regions as defined in SKA99 (Anon. 2000), here denoted by BR1-BR4. The regions correspond well to the regions of the growth model (Sallnäs 1990). Certain functions, such as those for reduction for bark, are differentiated on Northern and Southern Sweden. BR1 and BR2 are here classified as Northern Sweden and BR3 and BR4 as Southern Sweden. Other data, such as minimum final felling age, need to be referred to by even smaller regions. Here, BR1 will be represented by the county of Västerbotten, BR2 by Dalarna, BR3 by Värmland, and BR4 by Jönköping.

Scenarios

The forest owners are constrained in the choice of treatments by the endowment of forest areas in different treatment groups. There are three such groups: production forest, forest with modified management, and reserves (this corresponds to the groups “Traditionell skötsel”, “Naturanpassad skötsel” and “Ingen avverkning” in SKA99 (Anon. 2000), respectively). A given distribution of the Swedish forest area on the treatment groups will here be termed a scenario. Four scenarios are studied: the NUL, BAS, FSC and FSC+ scenarios. The distribution of the forest on treatment groups for a given scenario is static, i.e. the initial distribution on treatment groups for a given scenario is preserved throughout the entire projection period.

Production forests correspond to forests where both thinning and final felling is allowed. Minimum final felling age is set according to the previous Forestry Act, which is roughly about ten years above current regulations. This is motivated by our impression that many forest owners, including large forest companies, due to environmental concerns, economic considerations or a need to ration forest for final felling, apply rules that are stricter than the current implementation of the Forestry Act. In the model, thinning is only allowed for age classes that are not permissible for final felling. Final felling is in the form of clear felling. The treatment group with modified management differs from the first in that only thinning is allowed. Thinning is permissible for all established forest irrespective of age. Forests set aside as reserves have neither thinning nor final felling. All treatment groups share the same growth model given by equation (1).

A data set consisting of 21,301 NFI data plots from 1996, 1997 and 1998 was prepared. The area is 22.4 mill. hectares, which corresponds to the productive forest area in Sweden, reduced with 1 mill. hectares of existing and planned reserves with legal protection. The planned reserves are based on an estimate made in the SKA study of the likely area to be protected up to about 2010 (Anon. 2000).

Distribution of the areas associated with the NFI plots on treatments groups for a particular scenario was accomplished in the following way. In the plot data there are two variables that describe the value of the plot for nature conservation (for a description of the variables, see Appendix 1). Each variable is coded from 1 to 6 in such a way as to give value 1 to the most valuable plots and value 6 to those with no or very small value for biodiversity according to current judgments. This means that there are 36 combinations of values for the two variables where a combination 1x1 would mean that the plot has very high priority for being set aside and a combination 6x6 that it has very little environmental value. For a particular scenario it was decided, for each balance region (BR1-BR4) and owner category (NIPF owners and other, respectively), how plots belonging to each of the 36 combinations should be classified, i.e. if the plot should belong to production forest, forest with modified management or reserves. The delineation was done subjectively and in such a way that (i) plots that were regarded to have the most valuable combination were placed in the reserve area, next in the modified management group and the rest in production forest, and (ii) that the area target for each balance region and owner group were met (details are given in Appendix 2). The result of these procedures on an aggregate level is presented in Table 1.

Table 1. The distribution of the forest area on treatment groups (mill. hectares)

Scenario		Production forest	Modified management	Reserve area	Sum
NUL	Established forest	14.53	0	0	14.53
	Young forest	7.86	0	0	7.86
	Sum	22.39	0	0	22.39
	Share of total area (%)	100	0	0	100
BAS	Established forest	13.08	0.71	0.73	14.52
	Young forest	7.32	0.33	0.21	7.86
	Sum	20.40	1.04	0.94	22.38
	Share of total area (%)	91	5	4	100
FSC	Established forest	11.68	0.75	2.10	14.53
	Young forest	6.64	0.38	0.85	7.87
	Sum	18.32	1.13	2.95	22.40
	Share of total area (%)	82	5	13	100
FSC +	Established forest	10.37	1.40	2.76	14.53
	Young forest	5.98	0.66	1.21	7.85
	Sum	16.36	2.06	3.97	22.39
	Share of total area (%)	73	9	18	100

The principles behind the distribution of areas, as reflected in Table 1, are the following. The NUL scenario is here included as a reference in order to assess the maximum economic potential and lacks essentially practical significance in today's forestry. Note, however, that also in this scenario existing and potential reserves with legal protection are excluded from harvest.

Whereas BAS scenario only includes environmental considerations induced by the Forestry Act, the SKA study reflects the environmental restrictions applied by Swedish forestry at the end of the 90's. Subsequently the SKA study encompasses forest owners that already, to a smaller or larger extent, have implemented the FSC or some other certification scheme. The distribution of areas for the BAS scenario follows the SKA study (Anon. 2000) as regards areas with modified management. What is in this study termed reserves includes areas protected from harvests in the form of care demanding patches and biotopes as well as areas that become unattainable due to retention trees left at harvesting sites. The areas designated as reserves in the BAS scenario follow what in the SKA study is set aside as care demanding patches and biotopes, amounting to about two percent for each category. However, in the SKA study the effect of retention trees is not included in the reserve areas but calculated as a separate effect. As this effect is included in the reserve area in the BAS scenario it is less restrictive than the SKA study. The BAS scenario could therefore be interpreted as forestry with no adherence to the particular stipulations of the FSC standard.

The FSC scenario is intended to reflect a situation where the FSC certification standard is applied to all forests in Sweden. The FSC standard prescribes that at least 5 percent of the productive forest area should be set aside (two percent in the SKA study). A further 3.5 percent constitutes smaller care demanding patches that should not be harvested (two percent in the SKA study). The effect of retention trees left at the harvesting sites is estimated to reduce the available area with 4.5 percent. This amounts to a total of 13 percent. The area with modified management remains essentially the same as in the BAS scenario, but is somewhat rearranged due to the increased area requirements of reserves. The FSC+ scenario means that another four and five percent, compared with the FSC scenario, are added to the areas of modified management and reserves, respectively.

Economic data

Prices on timber and pulpwood were calculated as averages for the years 1996-1998 for pine and spruce, whereas broadleaves only qualified as pulpwood. Pulpwood prices is collected from the Official Statistics of Sweden (Anon. 1999). Price lists for timber are for BR1 from Norra Skogsägarna, Umeå district, for BR2 and BR3 from Mellanskog and the price lists applicable for Dalarna and Värmland, respectively, and for BR4 from Södra Skogsägarna, Jönköping district. Timber prices of standard assortment is given over diameter for five quality classes for pine and four classes for spruce in the price lists. They are weighted together into one price list for each species and region by using statistics on the distribution on quality from three timber measurements associations (VMF 1998), assuming that the distribution of volumes over diameter classes does not differ between qualities. Log conversion is calculated using the method of Ollas (1980) with the relation of volume over and under bark given by Näslund (1947).

Species composition and dimension is of importance for the economic return from harvests. The growth model includes three broad species classes: more than 50 percent conifers and pine and spruce dominated, respectively, and more than 50 percent broadleaves. For a better estimation of the species distribution in individual states of the model, species distribution functions were developed from NFI-data (see Appendix 4). Diameter is not projected in the growth model. Therefore, average diameter functions were elaborated (see Appendix 5) as a basis for the application of the conversion functions in individual states of the growth model.

Costs for cleaning, scarification, planting (excluding plants) and precommercial thinning on a per hectare basis is from Skogsstyrelsen (1999) for Northern and Southern Sweden, respectively. Plant cost is from Svenska Skogsplantor (1999) and the number of plants differentiated on region and site index.

Harvesting costs for thinning and final felling were estimated with functions for harvester and forwarder from Anon. (1989). In order to account for the increased productivity since 1987, the input data on cost per hour was reduced such that cost per cubic metre was the same for a tree with 20 cm diameter at breast height as the cost given in Skogsstatisktisk årsbok (19xx). (Further details on prices etc. are given in Appendix 3.)

The cost of capital, i.e. the discount rate, was estimated in the same way as presented by Berck and Bible (1984). Assuming that the model is correct, a discount that gives model results that coincides with observed behavior is determined. Running the model for the first two five year periods under the BAS scenario shows that a discount rate of 2.5 percent generates a harvest level that quite closely coincides with the current harvest level in Sweden (Table 2). The discount rate used in the model is an after tax real rate of return. From that point of view a discount rate of 2.5 percent appears reasonable and will be used in subsequent analyses.

Table 2. Annual harvest during the first 10 years of simulation (mill. m3) at different discount rates under the BAS scenario

Discount rate (%)										
2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
61.6	66.0	67.3	71.1	72.6	76.3	81.1	83.5	87.3	91.5	96.6

Results

The total annual harvest during the first 10 years of simulation is in the BAS scenario 76.3 mill. m^3 (Table 3). This level is 10 percent higher than that of scenario FSC and 15 percent higher than FSC+, while the NUL alternative would yield some 7 percent higher harvest level than that of the BAS scenario. These differences are rather well reflected in the results for the individual balance regions, with BR 3 as the only exception. Here we notice that there is only a marginal difference between the FSC and FSC+ scenarios.

Table 3. Annual harvest for the first 10 years, for different scenarios with relative price 1.0. The figures for scenario BAS are given in mill. m^3 and for the other scenarios in percent of scenario BAS

Scenario	**BR1**	**BR2**	**BR3**	**BR4**	**Total**
NUL	110	106	104	105	107
BAS	*27,1*	*18,4*	*7,7*	*23,1*	*76,3*
FSC	89	91	92	91	91
FSC+	84	85	91	84	85

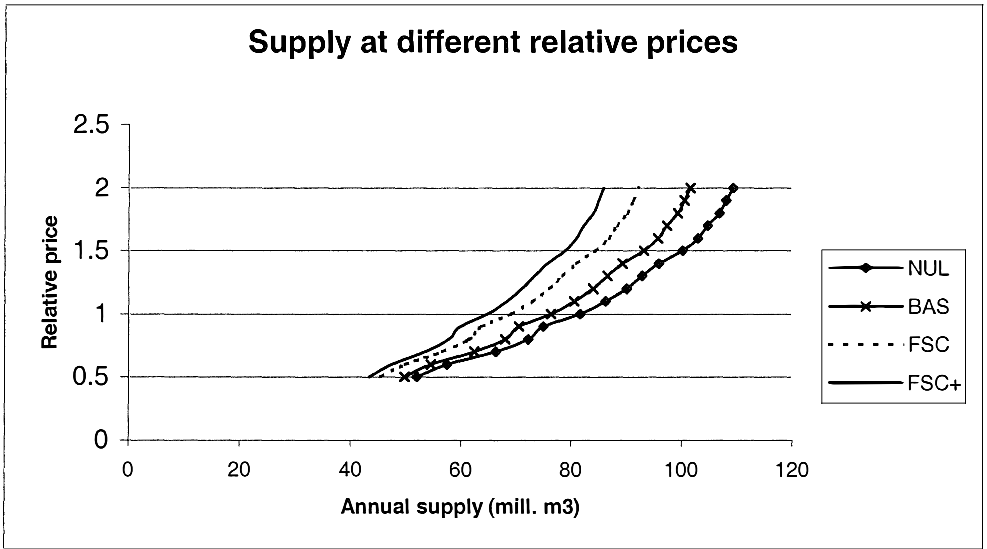


Figure 1. Annual supply first 10 years for different scenarios and different relative prices.

In Figure 1 the average supply the first 10 years is given for a gradient of relative prices. One implication of the results is that in order to reach the same short-term harvesting level in the FSC scenario as in the BAS scenario, the price level must be increased with some 17 percent. The corresponding figure for the FSC+ scenario is just below 40 percent. Another perspective of the same phenomenon is offered by looking at the price elasticities. Calculating over a 20-percent interval on both sides of relative price 1.0, we get elasticities ranging from 0.55 to 0.51, with the more "environmental" scenarios in the lower end. As expected, the elasticities are decreasing with an increased price level.

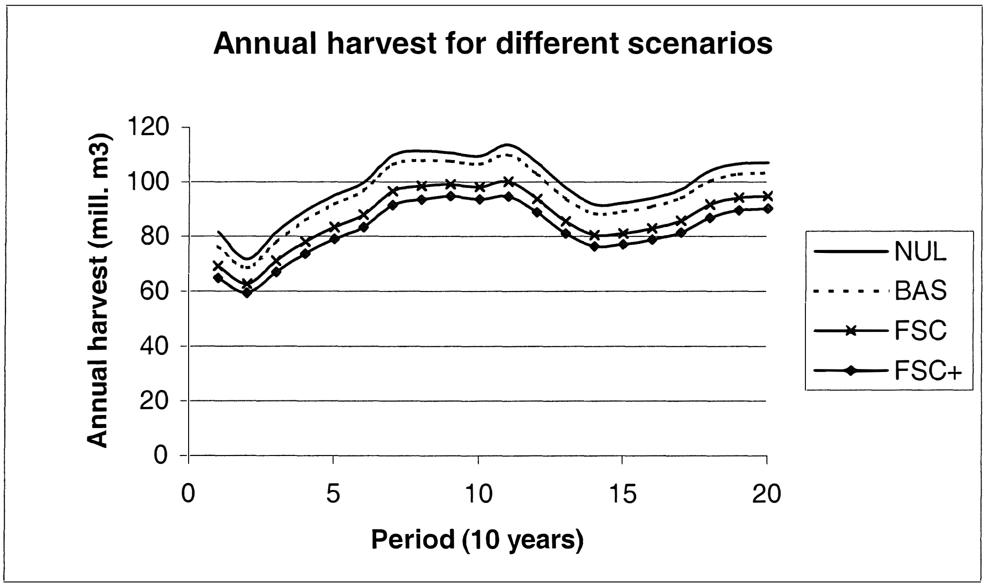


Figure 2. Annual harvest over time for the four different scenarios at a relative price level of 1.0.

In Figure 2 the development over time of annual harvests is given for the different scenarios at a price level of 1.0. The curves follow each other consistently. The dip in the second period is found for all scenarios. This is probably due to an adjustment of the forest state to the economic assumptions of the model; existing over-mature forest, from an economic point of view, is harvested in the first period, leading to a reduced supply in the next period. The rest of the century we find a rather steady increase in harvests. After a decrease for some periods the harvests reach the former high level at the end of the simulations. The differences between the curves remains essentially the same over the planning horizon.

The price effects on harvest levels illustrated in Figure 1 are in the short term, in this case the first 10 years. In Figure 3 the long-term harvest development for a number of selected combinations of scenario and price level are compared to that of the BAS scenario at price level 1.0. The initial increase of harvests as an effect of a higher price is counteracted by a later decrease compared to the reference development. Although it is possible even in the FSC scenario, by increasing the price, to reach the BAS harvest level in the beginning of the simulation the subsequent decrease in harvest level is significant.

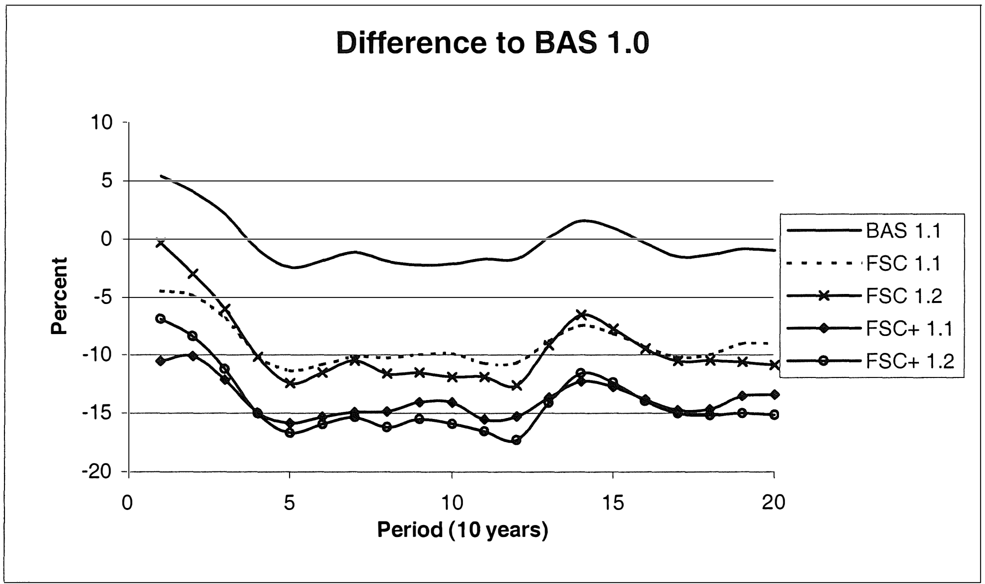


Figure 3. Harvests over time for some scenarios at different price levels as a relative difference to the level of the BAS scenario at price level 1.0

If we sum the harvest over 100 years in the different scenarios and compare it to the harvest of scenario BAS with price 1.0 we get the results shown in Table 4. Prices affect mainly the distribution over time of harvests. It is evident that the total harvest over the 100 years is more or less the same irrespective of the price level. However, it seems that a strong increase in prices will initially result in a high harvest level, which in the long run yields a somewhat lower total. Another result is that the FSC scenario "costs" 10-11 percent of the harvest level of BAS at all price levels. The corresponding figure for the FSC+ scenario is 13-14 percent.

Table 4. Average harvest over 100 years in relation to the BAS scenario for different price levels

	BAS			FSC			FSC+		
Relative price level	**1.0**	**1.1**	**1.2**	**1.0**	**1.1**	**1.2**	**1.0**	**1.1**	**1.2**
Relative harvest	1,00	0,99	0,99	0,91	0,91	0,90	0,87	0,86	0,86

A marked difference between the different scenarios is the part of the total harvest that stems from final fellings. In the FSC+ scenario, the area allocated to modified management, and consequently to thinning as the only available management option is larger than in the BAS and FSC scenarios. Consequently the thinning part of the harvest increases. The initial peak in harvest in figure 2 is also found in this figure with respect to final harvest. This underlines that the forest state is, by management, adjusted in the first period to the economic assumptions of the model. Those forest areas, initially present, that are over-mature in relation to the economic setting, are harvested.

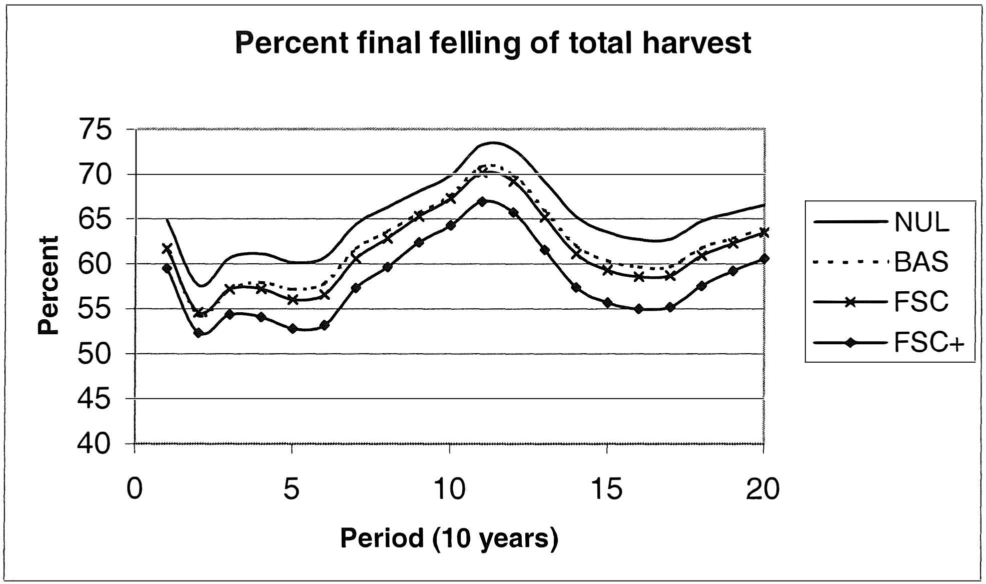


Figure 4. The percentage of final fellings of the total harvests for different scenarios. All scenarios are run with a relative price level of 1.0.

Discussion

Comparing the scenarios in terms of harvests the first 10 years shows that the management of today, expressed as the BAS scenario, features a supply level that is 7 percent lower than that of a situation where all forest land is used entirely for timber production. The FSC and FSC+ scenarios compared with BAS feature 10 and 15 percent lower level, respectively. These differences correspond well with the fraction of the forest area that is assigned to other uses than pure timber production.

As expected, the elasticities are decreasing over relative price. At a higher price and consequently a higher supply level, the elasticity decreases. The elasticities that are found can be compared to the elasticities estimated by for example Brännlund (1988), who finds elasticities of the same magnitude as those found in this study. The relatively low elasticities already at a price level of 1.0, implies that to compensate in the short run for the decrease of supply that would follow from the extended conservation measures in the FSC scenario, prices should have to be raised substantially. This result is of course artificial in the sense that it is not a prognosis saying that prices will actually raise. The domestic relation between price and supplies quantity is only one component. Other factors are import of round wood and the international competitiveness of the forest sector. The implication is rather that that extended conservation measures would increase the strain on the wood consuming industry.

A number of other assumptions, that range from basic economic assumptions to details of the sub-models, need to be scrutinized in order to correctly appreciate the results. The most important, hopefully, will here be brought to attention.

The scenarios of the study are of course more or less theoretical constructs. The BAS scenario is intended to reflect management that only meets the requirements of the current Forestry Act. In order to construct this scenario, the restrictions of the BAS study with the exception of the effect of retention trees was implemented. There is, however, limited data to support that the ensuing result is actually what would have been forestry without certification. The FSC scenario has a more well founded basis in the stipulations of the FSC standard. Still, how much the standard will add up compared to the Forestry Act can be debated. It should be emphasized that the BAS scenario should not be confused with current forestry practice since more than half the Swedish forest area is already subject to FSC or other certification standards.

The economic model used in this study is based on two important assumptions. Forest managers are supposed to act according to "economic man" rationality, i.e. he is in every situation supposed to take the action that maximizes the present net value of the forestry. This is a simplification, which however can be motivated by the fact that this type of studies should not primarily be interpreted as prognoses or projections, but rather as model studies that that should clarify the relations between economic entities.

The second assumption is that the forest manager at every decision making step expects prices and costs not to change in the future. This assumption, that markets exhibit a rational expectations equilibrium, is supported by a large number of investigations of financial markets (Brealey and Myers 2000). It has also found support in studies of timber markets (Washburn and Binkley 1990), although contradictive results are reported (Lohmander 1988).

At a discount rate of 2.5 percent the model harvest is in level with the current harvests in Sweden. Decisions about activities are controlled in the model by the basic assumption of "economic man" behavior, while in reality decisions have a much more complex background. Despite this, it is a reasonable approach to seek a harvest level by choosing a proper discount rate, so that investigations of elasticities can start out from a realistic level. The reasonableness of the combination of discount rate and harvest level should also give credibility to the model as such. At the same time it should be observed that more in depth inspections of the data show that the distribution over balance regions does not reflect the factual situation in Sweden today.

Using the ranking of the plots as the basis for distribution on treatment groups implies that forest areas with the highest nature conservation value will get the most extended protection. From this follows that the distribution is probably made in a more efficient way from a nature conservation point of view than is possible in an actual situation. In the latter case, effects of estate borders, lack of accurate data etc. will also influence the choice.

A related issues pertains to the fact that the distribution of the forest land on the groups is assumed to be permanent throughout time. This means that the setting aside of forest land for conservational purposes or the assignment of specific management programs to areas is unchanged through the simulations. Consequently no areas grow "in" or "out" of a treatment group, although some of the criteria used for distributing the area refer to variables that are connected to the tree layer and thereby could change over time. This is probably of limited importance with respect to the results of the study.

Retention trees has, in the model, the effect that a certain area is classified as reserve and the area is not accessible for harvest. However, in actual forestry, this area could subject to thinning (in future forest generations it will not, though). The amount that is extracted will subsequently be underestimated. Yet, the effect is very small due to the combination of limited areas subject to thinning in this treatment group and the thinning intensity in Swedish forests.

The same transition probabilities are used irrespective of treatment group. This means that growth under a continuous forest cover, i.e. modified management, is projected with the same growth model as forest management under a final felling regime. There is limited data to support this assumption. The effects on the results should be very small as the harvest volumes from this treatment group are limited.

Diameter and species composition is not projected by the forest growth module. Instead these parameters are estimated by regression functions from the present state of the forest, and applied for the entire simulation period. This means that diameter or species composition of a certain forest type does not change during simulations, irrespective of management. For instance, management that improves the conditions for broad-leaved species is not reflected in the model

The forest growth module inherent in the model probably yields a too low increment level, especially in the southern part of Sweden, as have been shown in other studies where the growth model has been employed (Sallnäs 1990). In this study the effect is that future harvest levels may be underestimated, notably in balance region 4. However, the main principal results of the study would not be affected.

Conclusions

Given the assumptions that have been defined in the study some conclusions can be drawn:

- Under forest management regimes that follow the certification standards, the future supply of timber would be significantly lower than the increment level, and will also feature a time profile differing from those of other more biologically based studies.
- An extended adaptation of Swedish forestry practices to the certification standards would, at constant prices, lead to a decreased supply.
- Given additional conservation considerations, keeping the domestic timber supply at the present level, would demand strong price increases.
- The positive short term effect of a price increase on supplied quantity would not be sustainable in the long run.

The ongoing adaptation of Swedish forestry to the standards of the certification programs will have significant effects on the timber supply. Ensuring the forest industry future good access to Swedish raw material may demand price changes that probably will affect the international competitiveness of the Swedish forest sector. Effects and tendencies like these should form integral parts of future analyses of wood balances and wood supply in a regional perspective.

References

Anon. 1989. Områdeskalkyler – skog, mellersta Sverige. Rapport 151. Konsulentavdelningen, Swedish University of Agricultural Sciences. Uppsala.

Anon. 1998. Swedish FSC Standard for Forest Certification. Report from the Swedish FSC-council. (www.fsc-sverige.org)

Anon. 1999. Skogsstatistisk årsbok 1999 (Statistical Yearbook of Forestry 1999). Skogsstyrelsen (National Board of Forestry). Jönköping.

Anon. 2000. Skogliga konsekvensanalyser 1999. Report No. 2. Swedish Board of Forestry. Jönköping. (In Swedish.)

Berck, P. and Bible, T. 1984. Solving and interpreting large-scale harvest scheduling problems by duality and decomposition. For Sci. 30:173-182.

Brealey, R.A. and Myers, S.C. 2000. Principles of corporate finance (6. ed.). McGraw-Hill. Boston.

Brännlund, R. 1988. The Swedish Roundwood Market. Report 82, Department of Forest Economics, SLU, Umeå..

Denardo, E. 1982. Dynamic Programming. Prentice-Hall. Englewood Cliffs, N.J.

Johnsson, P.-O. & Löfgren, K.G. 1985. The Economics of Forestry and Natural Resources. Basil Blackwell Inc. New York.

Lohmander, P. 1988. Pulse extraction under risk and a numerical forestry example. Systems Anal., Model. and simulation 4:339-354.

Lundström, A., Nilsson, P, and Ståhl, G. 1997. Certifieringens konsekvenser för möjliga framtida uttag av industri- och energived. En pilotstudie. (In Swedish.) SLU, Department of Forest Resource Management and Geomatics. Working paper 23.

Ollas, R. 1980. Nya utbytesfunktioner för träd och bestånd. Ekonomi Nr 5. Forskningsstiftelsen Skogsarbeten. Stockholm.

Näslund, M. 1947. Funktioner och tabeller för kubering av stående träd : tall, gran och björk i södra Sverige samt i hela landet. Meddelanden från Statens skogsforskningsinstitut ; 36:3. Stockholm.

Sallnäs, O. and Eriksson, L.O. 1989. Management variation and price expectations in an intertemporal forest sector model. Natural Resource Modeling, 1989:3: x-x.

Sallnäs, O., 1990. A matrix growth model of the Swedish forest. Studia Forestalia Suecica. No. 183. SLU. Uppsala.

Skogsstyrelsen 1999. Storskogsbrukets kostnader för åtgärder på egen skogsmark år 1998. Jfr. nr. 1998:59. Skogsstyrelsen (National Board of Forestry). Jönköping.

Svenska Skogsplantor 1999. Svenska Skogsplantor 2000. Svenska Skogsplantor AB. Jönköping.

Verkaik, E. and Nabuurs, G.J. 2000. Wood production potentials of Fenno-Scandinavian forests under nature-orientated management. Scandinavian Journal of Forest Research 15: 445-454.

VMF 1998. Årsredovisning för verksamhetsåret 1997/98. VMF Nord ek. för., Umeå; Wermländska inmätningsföreningen ek. för., Karlstad; Virkesmätningsföreningen Syd ek. för., Jönköping.

Washburn, C.L. and Binkley, C.S. 1990. Informational Efficiency of Markets for Stumpage. Amer. J. Agr. Econ. pp. 394-405.

Appendix 1

Description of NFI plot variables designating value for nature conservation used to differentiate plots on different treatment groups

PRIOSTAT:

1. Naturskyddade områden eller områden som utgör skydd mot sand eller jordflykt eller områden med extremt klimat nära fjällkanten med stora föryngringssvårigheter

2. Område av naturskogskaraktär eller med spår av brand

3. Sumpskog (bottenskikt vitmossor eller sumpmossor), fuktig eller blöt mark, med slutenhet över 0.4

4. Kulturpåverkan eller betning av tamboskap eller markanvändning skogsmarksbete

5. Ytan ligger inom militärt övningsområde, i anslutning till tätort eller område med intensivt friluftsliv, klassats som tekniskt impediment eller "övriga former av annan markanvändning".

6. Inga restriktioner eller speciella hänsyn.

PRIOFLEX:

1. Medelålder över 175 år

2. Lövträdsandel minst 0.7 och med medelålder minst 80 år och frisk mark

3. Mindre än 25 m från hav, sjö eller större vattendrag (>5 m brett)

4. Mindre än 25 m från mindre sjö (0.02-5 ha) eller mindre vattendrag och högörtstyp

5. Mindre än 25 m från mindre sjö (0.02-5 ha) eller mindre vattendrag (andra fältskiktstyper än högört), eller mindre än 100 m från hav, sjö eller större vattendrag (>5 m brett), eller mindre än 100 m från bebyggelse eller läns/riks-väg.

6. Inga restriktioner eller speciella hänsyn.

Distribution of areas on treatment groups for different scenarios

Production forest
Modified management
Reserve area
More than one treatment group in the same class

For definitions on Stat (=priostat) and Flex (=prioflex), see Appendix 1.
Chat. : Owner category 1= Other; 2= NIPF owners

Scenario = SKA

Reg.	Chat.	Flex	Stat 1	2	3	4	5	6	Sum	Sum per group (and 1000 ha) Prod	Modified	Reserve
1	1	1	0.22	0.78	0.14	0.00	0.05	1.20	2.40	89.14	5.90	4.96
		2	0.00	0.00	0.03	0.00	0.00	0.00	0.03	5436	360	302
		3	0.02	1.09	1.03	0.06	0.12	10.96	13.29			
		4	0.00	0.00	0.09	0.04	0.00	0.69	0.83			
		5	0.00	0.24	0.02	0.10	0.10	3.55	4.01			
		6	0.09	7.76	2.52	0.47	0.70	67.90	79.44			
		Sum	0.32	9.88	3.84	0.67	0.98	84.31	100.00			
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
1	2		0.07	0.16	0.08	0.00	0.12	1.05	1.49	94.18	3.03	2.79
			0.00	0.00	0.03	0.00	0.00	0.02	0.05	3832	123	113
			0.06	0.56	1.03	0.35	0.05	10.61	12.67			
			0.00	0.05	0.24	0.10	0.00	1.24	1.62			
			0.11	0.21	0.38	0.92	0.05	4.68	6.34			
			0.26	4.33	3.92	1.48	0.52	67.32	77.84			
			0.50	5.32	5.68	2.85	0.75	84.91	100.00			
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
2	1	1	0.03	0.38	0.12	0.03	0.16	1.16	1.89	89.17	5.88	4.95
		2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2496	165	139
		3	0.20	1.78	0.57	0.13	0.28	8.65	11.61			
		4	0.07	0.14	0.15	0.03	0.00	1.25	1.65			
		5	0.08	0.50	0.26	0.35	0.11	4.55	5.85			
		6	1.44	8.41	1.78	1.20	0.82	65.35	79.01			
		Sum	1.82	11.22	2.89	1.73	1.38	80.96	100.00			
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
2	2	1	0.00	0.42	0.04	0.00	0.00	0.50	0.96	92.40	3.70	3.90
		2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2104	84	89
		3	0.09	1.08	0.65	0.32	0.05	7.96	10.15			
		4	0.00	0.06	0.24	0.04	0.00	1.07	1.41			
		5	0.00	0.60	0.14	0.98	0.15	7.10	8.98			

Reg.	Chat.	Flex		1	2	3	4	5	6	Sum	Prod	Modified	Reserve
			6	0.29	4.51	2.20	2.83	0.05	68.62	78.50			
			Sum	0.38	6.68	3.27	4.17	0.26	85.24	100.00			

Reg.	Chat.	Flex		1	2	3	4	5	6	Sum	Prod	Modified	Reserve
3	1		1	0.00	0.00	0.00	0.00	0.00	0.25	0.25	91.01	4.79	4.21
			2	0.00	0.00	0.23	0.00	0.00	0.00	0.23	892	47	41
			3	0.38	0.22	0.58	0.37	0.64	9.31	11.51			
			4	0.28	0.00	0.46	0.07	0.00	1.61	2.42			
			5	0.23	0.08	0.29	0.51	0.70	6.38	8.19			
			6	3.29	2.10	3.30	2.47	2.18	64.07	77.41			
			Sum	4.18	2.40	4.86	3.42	3.52	81.62	100.00			

Reg.	Chat.	Flex		1	2	3	4	5	6	Sum	Prod	Modified	Reserve
3	2		1	0.00	0.00	0.00	0.00	0.00	0.32	0.32	91.31	4.32	4.37
			2	0.00	0.00	0.00	0.04	0.00	0.00	0.04	1552	73	74
			3	0.21	0.35	0.36	0.51	0.00	9.95	11.38			
			4	0.00	0.04	0.23	0.20	0.00	1.22	1.69			
			5	0.05	0.24	0.66	1.08	0.04	7.19	9.26			
			6	0.76	2.00	2.57	3.76	0.13	68.08	77.30			
			Sum	1.01	2.63	3.82	5.59	0.17	86.77	100.00			

Reg.	Chat.	Flex		1	2	3	4	5	6	Sum	Prod	Modified	Reserve
4	1		1	0.00	0.00	0.00	0.00	0.00	0.39	0.39	89.62	5.55	4.84
			2	0.00	0.00	0.15	0.00	0.00	0.00	0.15	937	58	51
			3	0.34	0.22	0.44	0.08	0.54	9.40	11.03			
			4	0.00	0.00	0.00	0.14	0.00	0.60	0.74			
			5	0.32	0.00	0.22	1.12	0.63	6.51	8.79			
			6	0.57	0.14	2.68	4.64	2.21	68.65	78.90			
			Sum	1.23	0.36	3.50	5.98	3.39	85.54	100.00			

Reg.	Chat.	Flex		1	2	3	4	5	6	Sum	Prod	Modified	Reserve
4	2		1	0.00	0.00	0.00	0.01	0.00	0.19	0.20	92.13	3.92	3.95
			2	0.00	0.00	0.06	0.00	0.00	0.00	0.06	3155	134	135
			3	0.16	0.09	0.49	0.53	0.10	7.76	9.12			
			4	0.00	0.01	0.11	0.31	0.00	0.50	0.93			
			5	0.08	0.00	0.26	2.51	0.17	6.97	10.00			
			6	0.42	0.14	2.35	10.54	0.01	66.24	79.69			
			Sum	0.67	0.23	3.26	13.90	0.28	81.66	100.00			

Scenario = FSC

				Stat							Sum per group (and 1000 ha)		
Reg.	Chat.	Flex		1	2	3	4	5	6	Sum	Prod	Modified	Reserve
1	1		1	0.22	0.78	0.14	0.00	0.05	1.20	2.40	80.96	5.03	14.01
			2	0.00	0.00	0.03	0.00	0.00	0.00	0.03	4937	307	854
			3	0.02	1.09	1.03	0.06	0.12	10.96	13.29			
			4	0.00	0.00	0.09	0.04	0.00	0.69	0.83			
			5	0.00	0.24	0.02	0.10	0.10	3.55	4.01			
			6	0.09	7.76	2.52	0.47	0.70	67.90	79.44			
			Sum	0.32	9.88	3.84	0.67	0.98	84.31	100.00			

Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
1	2	1	0.07	0.16	0.08	0.00	0.12	1.05	1.49	80.97	4.98	14.05
		2	0.00	0.00	0.03	0.00	0.00	0.02	0.05	3294	203	572
		3	0.06	0.56	1.03	0.35	0.05	10.61	12.67			
		4	0.00	0.05	0.24	0.10	0.00	1.24	1.62			
		5	0.11	0.21	0.38	0.92	0.05	4.68	6.34			
		6	0.26	4.33	3.92	1.48	0.52	67.32	77.84			
		Sum	0.50	5.32	5.68	2.85	0.75	84.91	100.00			

Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
2	1	1	0.03	0.38	0.12	0.03	0.16	1.16	1.89	81.99	5.00	13.00
		2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2296	140	364
		3	0.20	1.78	0.57	0.13	0.28	8.65	11.61			
		4	0.07	0.14	0.15	0.03	0.00	1.25	1.65			
		5	0.08	0.50	0.26	0.35	0.11	4.55	5.85			
		6	1.44	8.41	1.78	1.20	0.82	65.35	79.01			
		Sum	1.82	11.22	2.89	1.73	1.38	80.96	100.00			

Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
2	2	1	0.00	0.42	0.04	0.00	0.00	0.50	0.96	82.00	5.00	13.00
		2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1867	114	296
		3	0.09	1.08	0.65	0.32	0.05	7.96	10.15			
		4	0.00	0.06	0.24	0.04	0.00	1.07	1.41			
		5	0.00	0.60	0.14	0.98	0.15	7.10	8.98			
		6	0.29	4.51	2.20	2.83	0.05	68.62	78.50			
		Sum	0.38	6.68	3.27	4.17	0.26	85.24	100.00			

Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
3	1	1	0.00	0.00	0.00	0.00	0.00	0.25	0.25	82.91	5.04	12.06
		2	0.00	0.00	0.23	0.00	0.00	0.00	0.23	813	49	118
		3	0.38	0.22	0.58	0.37	0.64	9.31	11.51			
		4	0.28	0.00	0.46	0.07	0.00	1.61	2.42			
		5	0.23	0.08	0.29	0.51	0.70	6.38	8.19			
		6	3.29	2.10	3.30	2.47	2.18	64.07	77.41			
		Sum	4.18	2.40	4.86	3.42	3.52	81.62	100.00			

Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
3	2	1	0.00	0.00	0.00	0.00	0.00	0.32	0.32	83.00	5.02	11.99
		2	0.00	0.00	0.00	0.04	0.00	0.00	0.04	1411	85	204
		3	0.21	0.35	0.36	0.51	0.00	9.95	11.38			
		4	0.00	0.04	0.23	0.20	0.00	1.22	1.69			
		5	0.05	0.24	0.66	1.08	0.04	7.19	9.26			
		6	0.76	2.00	2.57	3.76	0.13	68.08	77.30			
		Sum	1.01	2.63	3.82	5.59	0.17	86.77	100.00			

Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
4	1	1	0.00	0.00	0.00	0.00	0.00	0.39	0.39	82.94	5.05	12.01
		2	0.00	0.00	0.15	0.00	0.00	0.00	0.15	868	53	126
		3	0.34	0.22	0.44	0.08	0.54	9.40	11.03			
		4	0.00	0.00	0.00	0.14	0.00	0.60	0.74			
		5	0.32	0.00	0.22	1.12	0.63	6.51	8.79			
		6	0.57	0.14	2.68	4.64	2.21	68.65	78.90			

		Sum	1.23	0.36	3.50	5.98	3.39	85.54	100.00			

Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
4	2	1	0.00	0.00	0.00	0.01	0.00	0.19	0.20	82.97	4.99	12.04
		2	0.00	0.00	0.06	0.00	0.00	0.00	0.06	2842	171	412
		3	0.16	0.09	0.49	0.53	0.10	7.76	9.12			
		4	0.00	0.01	0.11	0.31	0.00	0.50	0.93			
		5	0.08	0.00	0.26	2.51	0.17	6.97	10.00			
		6	0.42	0.14	2.35	10.54	0.01	66.24	79.69			
		Sum	0.67	0.23	3.26	13.90	0.28	81.66	100.00			

Scenario = FSC+

					Stat					Sum per group (and 1000 ha)		
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
1	1	1	0.22	0.78	0.14	0.00	0.05	1.20	2.40	71.03	10.00	18.97
		2	0.00	0.00	0.03	0.00	0.00	0.00	0.03	4332	610	1157
		3	0.02	1.09	1.03	0.06	0.12	10.96	13.29			
		4	0.00	0.00	0.09	0.04	0.00	0.69	0.83			
		5	0.00	0.24	0.02	0.10	0.10	3.55	4.01			
		6	0.09	7.76	2.52	0.47	0.70	67.90	79.44			
		Sum	0.32	9.88	3.84	0.67	0.98	84.31	100.00			
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
1	2	1	0.07	0.16	0.08	0.00	0.12	1.05	1.49	71.02	9.96	19.02
		2	0.00	0.00	0.03	0.00	0.00	0.02	0.05	2889	405	774
		3	0.06	0.56	1.03	0.35	0.05	10.61	12.67			
		4	0.00	0.05	0.24	0.10	0.00	1.24	1.62			
		5	0.11	0.21	0.38	0.92	0.05	4.68	6.34			
		6	0.26	4.33	3.92	1.48	0.52	67.32	77.84			
		Sum	0.50	5.32	5.68	2.85	0.75	84.91	100.00			
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
2	1	1	0.03	0.38	0.12	0.03	0.16	1.16	1.89	72.02	9.99	18.00
		2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2016	280	504
		3	0.20	1.78	0.57	0.13	0.28	8.65	11.61			
		4	0.07	0.14	0.15	0.03	0.00	1.25	1.65			
		5	0.08	0.50	0.26	0.35	0.11	4.55	5.85			
		6	1.44	8.41	1.78	1.20	0.82	65.35	79.01			
		Sum	1.82	11.22	2.89	1.73	1.38	80.96	100.00			
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
2	2	1	0.00	0.42	0.04	0.00	0.00	0.50	0.96	82.00	10.01	17.97
		2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1867	228	409
		3	0.09	1.08	0.65	0.32	0.05	7.96	10.15			
		4	0.00	0.06	0.24	0.04	0.00	1.07	1.41			
		5	0.00	0.60	0.14	0.98	0.15	7.10	8.98			
		6	0.29	4.51	2.20	2.83	0.05	68.62	78.50			
		Sum	0.38	6.68	3.27	4.17	0.26	85.24	100.00			
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve

3	1	1	0.00	0.00	0.00	0.00	0.00	0.25	0.25	72.99	10.00	17.01
		2	0.00	0.00	0.23	0.00	0.00	0.00	0.23	716	98	167
		3	0.38	0.22	0.58	0.37	0.64	9.31	11.51			
		4	0.28	0.00	0.46	0.07	0.00	1.61	2.42			
		5	0.23	0.08	0.29	0.51	0.70	6.38	8.19			
		6	3.29	2.10	3.30	2.47	2.18	64.07	77.41			
		Sum	4.18	2.40	4.86	3.42	3.52	81.62	100.00			
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
3	2	1	0.00	0.00	0.00	0.00	0.00	0.32	0.32	83.00	5.02	11.99
		2	0.00	0.00	0.00	0.04	0.00	0.00	0.04	1411	85	204
		3	0.21	0.35	0.36	0.51	0.00	9.95	11.38			
		4	0.00	0.04	0.23	0.20	0.00	1.22	1.69			
		5	0.05	0.24	0.66	1.08	0.04	7.19	9.26			
		6	0.76	2.00	2.57	3.76	0.13	68.08	77.30			
		Sum	1.01	2.63	3.82	5.59	0.17	86.77	100.00			
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
4	1	1	0.00	0.00	0.00	0.00	0.00	0.39	0.39	82.94	9.98	17.01
		2	0.00	0.00	0.15	0.00	0.00	0.00	0.15	868	104	178
		3	0.34	0.22	0.44	0.08	0.54	9.40	11.03			
		4	0.00	0.00	0.00	0.14	0.00	0.60	0.74			
		5	0.32	0.00	0.22	1.12	0.63	6.51	8.79			
		6	0.57	0.14	2.68	4.64	2.21	68.65	78.90			
		Sum	1.23	0.36	3.50	5.98	3.39	85.54	100.00			
Reg.	Chat.	Flex	1	2	3	4	5	6	Sum	Prod	Modified	Reserve
4	2	1	0.00	0.00	0.00	0.01	0.00	0.19	0.20	73.01	10.00	16.99
		2	0.00	0.00	0.06	0.00	0.00	0.00	0.06	2500	343	582
		3	0.16	0.09	0.49	0.53	0.10	7.76	9.12			
		4	0.00	0.01	0.11	0.31	0.00	0.50	0.93			
		5	0.08	0.00	0.26	2.51	0.17	6.97	10.00			
		6	0.42	0.14	2.35	10.54	0.01	66.24	79.69			
		Sum	0.67	0.23	3.26	13.90	0.28	81.66	100.00			

Prices and associated data

Timber prices

Region	Species	12-	14-	16-	18-	20-	22-	24-	26-	28-	30+
		Top diameter class (cm)									
BR1	Pine	382	451	468	531	563	567	580	580	590	592
	Spruce	259	384	414	444	460	464	467	471	472	476
BR2	Pine		435	484	518	542	559	574	584	589	595
	Spruce		414	454	465	478	489	500	507	516	526
BR3	Pine		435	484	518	542	559	574	584	589	595
	Spruce		414	454	465	478	489	500	507	516	526
BR4	Pine	403	412	480	495	526	537	548	559	574	585
	Spruce	407	411	478	513	521	539	540	545	561	580

Pulpwood prices

Region	Pine	Spruce	Hardwood
BR1	219	236	228
BR2	229	250	254
BR3	229	250	254
BR4	254	271	275

Harvesting and silvicultural costs

	Region			
	BR1	BR2	BR3	BR4
Forwarder including operator (SEK/h)	357	357	357	357
Harvester in final felling including operator (SEK/h)	818	818	818	818
Harvester in thinning including operator (SEK/h)	612	641	678	720
Cleaning and precommercial thinning (SEK/h)	203	203	162	162
Scarification including operator (SEK/h)	934	934	1116	1116
Planting excluding plants (SEK/h)	170	170	170	170
Plants (SEK/1000)	2200	2200	2200	2200

Appendix 4

20000417

SMAC

— förekomst och volym av tall, gran och löv —

SMAC — funktioner för att skatta förekomst och volym av tall, gran och löv

Funktioner utvecklades för att skatta förekomst- och volym av tall, gran och löv på en provyta. Funktioner för förekomst av tall och gran tillämpas där respektive andel av volymen är 5-25% och för löv där den är 5-50%. Samma datamaterial som i ”SMAC — funktioner för att skatta beståndsdiametrar — 991116” användes. Linjära samband mellan beroende- och enskilda oberoende variabler har sökts. Funktioner har därefter byggts upp utifrån dessa linjära samband.

Logistisk regression har använts för att skatta förekomst av respektive trädslag och en multiplikativ regressionsmodell för att skatta volym. Olika statistiska variationsmått indikerar att enskilda prediktioner ibland är osäkra. I relation till slumpfel så verkar systematiska fel vara mycket små med i sammanhanget obetydliga trender över testade variabler. Enskilda oberoende variabler har hög signifikans. Det bör påpekas att funktionerna inte testats praktiskt.

Praktisk tillämpning kan ske på följande vis. Sannolikheten för förekomst (Y_F) av löv, tall och gran beräknas enligt formel 1.

[1] $$Y_{F_i} = \frac{\exp^{(b_{i0}+b_{i1}+...+b_{in_i})}}{1+\exp^{(b_{i0}+b_{i1}+...+b_{in_i})}}$$

Där i står för trädslag, b för parameterskattning och n för antalet parametrar. Tre olika slumptal mellan 0 och 1 dras och jämförs med dessa trädvisa skattade sannolikheter. Exempelvis dras slumptalen 0.840, 0.303 och 0.765 och skattningarna för löv, tall och gran blev 0.546, 0.782 och 0.954. Således anses tall och gran finnas på ytan.

Volymen (Y_V) kan skattas enligt formel 2.

[2] $$Y_{V_i} = \exp^{(b_{i0}+b_{i1}+...+b_{in}+MSE/2)}$$

Samma beteckningar som ovan används men här avses parameterskattningar för volymfunktioner. MSE hämtas från respektive funktion [(Root MSE)^2]. Om exemplet fortsätter skattas andelen av trädslagen enligt formel 3.

[3] Lövandel: $$\frac{0}{Y_{V_{löv}}+Y_{V_{tall}}+Y_{V_{gran}}}$$ Tallandel: $$\frac{Y_{V_{tall}}}{Y_{V_{löv}}+Y_{V_{tall}}+Y_{V_{gran}}}$$ Granandel: $$\frac{Y_{V_{gran}}}{Y_{V_{löv}}+Y_{V_{tall}}+Y_{V_{gran}}}$$

Variabler:

CON	1 om >50% barr av volym annars 0
HOJDOH	höjd över havet, [m]
BESTALD	beståndsålder (grundytevägd totalålder), [år]
TABON	tallbonitet, [10-dels m^3/ha•år] om volymen tall är större än för gran, annars 0
GRBON	granbonitet, [10-dels m^3/ha•år] om volymen gran är större än för tall, annars 0
VOLYM	total volym, [10-dels m^{3}sk/ha]
BONALLA	bonitet, [10-dels m^3/ha•år] för det trädslag av tall och gran som volymmässigt dominerar

TALLDOM	1 om volymen tall är större än för gran, annars 0 (OBS! denna definition skiljer mot den vid skattning av beståndsdiametrar 991116)

Resultat: ”Logistisk funktion som skattar ***förekomst*** av tall”.

OBSERVERA ATT YTOR MED MINDRE ÄN 5 OCH MER ÄN 25% TALL (AV VOLYM) EJ INGÅR

1	1	4105
2	0	8326

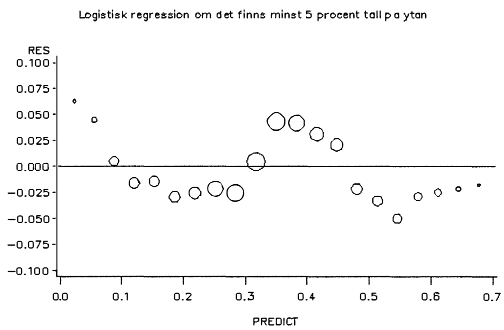
Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	15772.870	14765.814	.
SC	15780.298	14832.665	.
-2 LOG L	15770.870	14747.814	1023.056 with 8 DF (p=0.0001)
Score	.	.	930.763 with 8 DF (p=0.0001)

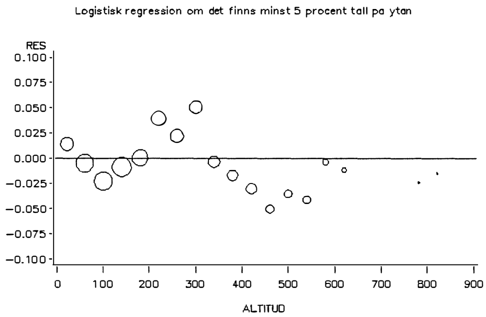
Analysis of Maximum Likelihood Estimates

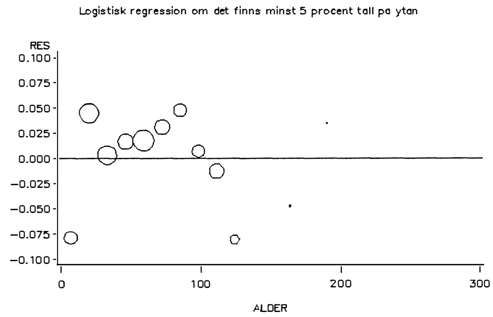
Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	
INTERCPT	1	-0.0675	0.1597	0.1788	0.6724	.	
CON	1	1.2002	0.0687	305.3607	0.0001	0.298875	(0 eller 1[>50% BARR AV VOL.])
HOJDOH	1	0.00159	0.000488	10.6582	0.0011	0.135427	[m]
HOH2	1	-8.58E-6	8.758E-7	95.9105	0.0001	-0.437589	$HOJDOH^2$
BESTALN	1	-0.1159	0.0359	10.4497	0.0012	-0.052113	ln(BESTALD); [år]
TABON	1	-0.00861	0.00165	27.0975	0.0001	-0.092717	(0 eller tallbon.); [0.1 m3/ha•år]
GRBON	1	-0.0189	0.000874	468.3766	0.0001	-0.427263	(0 eller granbonitet)
VOLYM	1	0.000297	0.000049	36.7086	0.0001	0.222179	[dm^3]
VOLYM2	1	-3.14E-8	8.069E-9	15.1229	0.0001	-0.123893	$VOLYM^2$

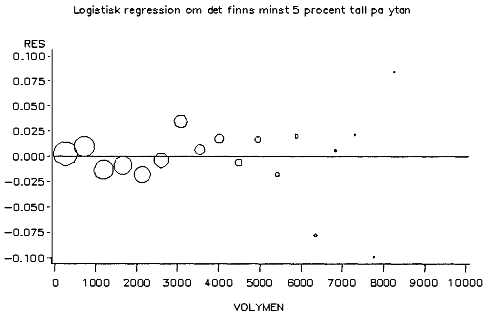
Association of Predicted Probabilities and Observed Responses

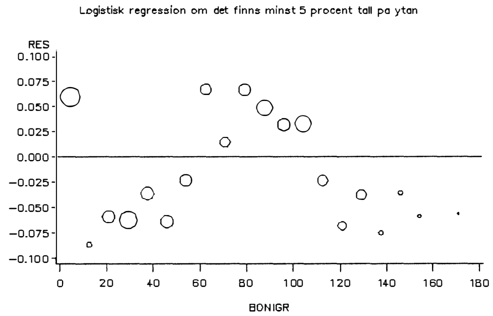
Concordant	67.2%	Somers' D	0.348
Discordant	32.4%	Gamma	0.349
Tied	0.4%	Tau-a	0.154
(34178230 pairs)		c	0.674











Resultat: ”Logistisk funktion som skattar ***förekomst*** av gran”.

OBSERVERA ATT YTOR MINDRE ÄN 5 OCH MED MER ÄN 25% GRAN (AV VOLYM) EJ INGÅR.

1	1	6257
2	0	7322

Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	18742.877	17873.764	.
SC	18750.394	17933.894	.
-2 LOG L	18740.877	17857.764	883.113 with 7 DF (p=0.0001)
Score	.	.	852.572 with 7 DF (p=0.0001)

Analysis of Maximum Likelihood Estimates

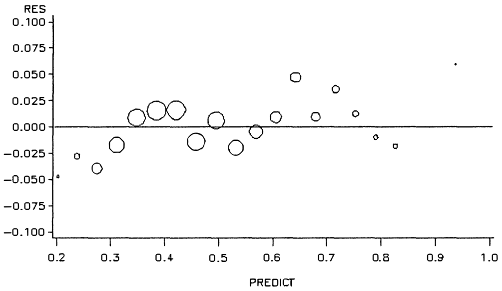
Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	-3.3533	0.7715	18.8931	0.0001	.	.
CON	1	-0.0435	0.0450	0.9336	0.3339	-0.010532	0.957
HOJDOH	1	0.000893	0.000136	42.9271	0.0001	0.073993	1.001
BESTALN	1	0.1850	0.0274	45.6213	0.0001	0.087047	1.203
BONALLA	1	-0.0223	0.0142	2.4600	0.1168	-0.276720	0.978
BONALN	1	0.6491	0.3328	3.8037	0.0511	0.171895	1.914
BONA2	1	0.000211	0.000067	9.9274	0.0016	0.316137	1.000
VOLYM	1	0.000286	0.000023	158.5119	0.0001	0.170416	1.000

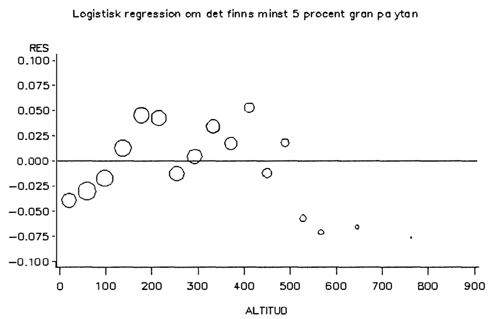
Bonalla avser bonitet [m3/ha•år]för det trädslag av tall och gran som volymsmässigt dominerer.

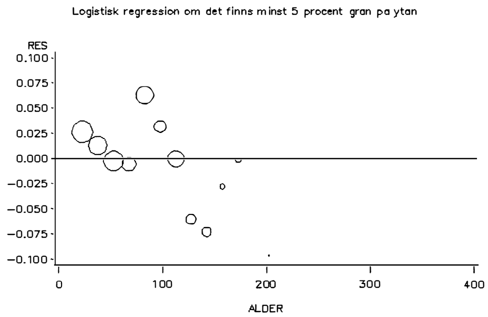
Association of Predicted Probabilities and Observed Responses

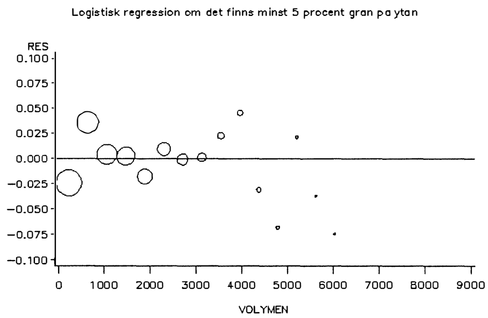
Concordant	= 64.1%	Somers' D	= 0.287
Discordant	= 35.4%	Gamma	= 0.288
Tied	= 0.5%	Tau-a	= 0.143
(45813754 pairs)		c	= 0.643

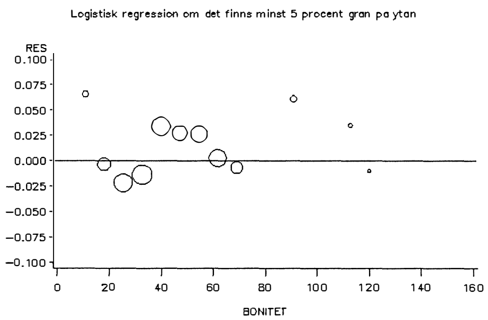
Logistisk regression om det finns minst 5 procent gran pa ytan




Logistisk regression om det finns minst 5 procent gran pa ytan
RES
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100
0
100
200
300
400
500
600
700
800
900
ALTITUD


Logistisk regression om det finns minst 5 procent gran pa ytan
RES
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100
0
100
200
300
400
ALDER


Logistisk regression om det finns minst 5 procent gran pa ytan
RES
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
VOLYMEN


Logistisk regression om det finns minst 5 procent gran pa ytan
RES
0.100
0.075
0.050
0.025
0.000
−0.025
−0.050
−0.075
−0.100
0
20
40
60
80
100
120
140
160
BONITET

Resultat: ”Logistisk funktion som skattar ***förekomst*** av löv”.

OBSERVERA ATT YTOR MED MINDRE ÄN 5 OCH MER ÄN 50% LÖV (AV VOLYM) EJ INGÅR.

1	1	7212
2	0	11715

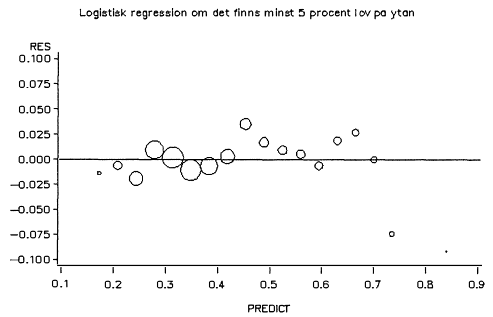
Criterion	Intercept Only	Intercept and Covariates	Chi-Square for Covariates
AIC	25158.723	24036.581	.
SC	25166.572	24107.216	.
-2 LOG L	25156.723	24018.581	1138.143 with 8 DF (p=0.0001)
Score	.	.	1139.566 with 8 DF (p=0.0001)

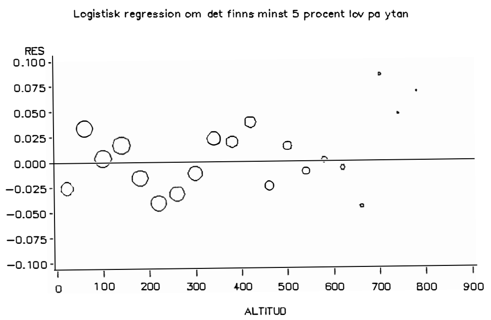
Analysis of Maximum Likelihood Estimates

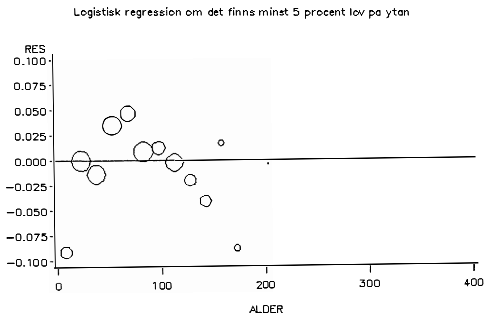
Variable	DF	Parameter Estimate	Standard Error	Wald Chi-Square	Pr > Chi-Square	Standardized Estimate	Odds Ratio
INTERCPT	1	5.1171	0.4928	107.8301	0.0001	.	.
HOJDOH	1	-0.00122	0.000126	94.5172	0.0001	-0.100607	0.999
BESTALD	1	-0.00264	0.000519	25.7736	0.0001	-0.058968	0.997
TABON	1	-0.0155	0.00519	8.9342	0.0028	-0.220042	0.985
TABONLN	1	0.4289	0.2108	4.1421	0.0418	0.444325	1.536
GRBON	1	0.00200	0.00253	0.6273	0.4283	0.047685	1.002
GRBONLN	1	-1.1607	0.1570	54.6552	0.0001	-1.341098	0.313
VOLYM	1	-0.00011	0.000017	38.8963	0.0001	-0.073659	1.000
TALLDOM	1	-6.2151	0.7320	72.0795	0.0001	-1.710079	0.002

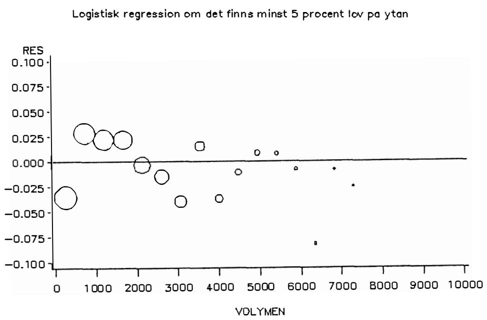
Association of Predicted Probabilities and Observed Responses

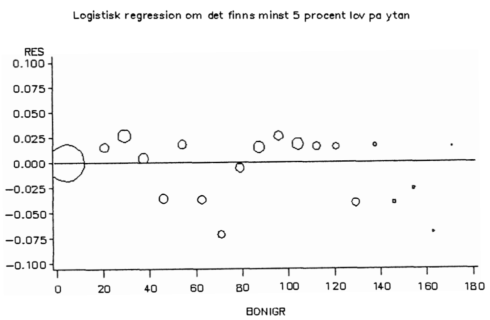
Concordant	= 63.5%	Somers' D	= 0.276
Discordant	= 35.9%	Gamma	= 0.278
Tied	= 0.6%	Tau-a	= 0.130
(84488580 pairs)		c	= 0.638




Logistisk regression om det finns minst 5 procent lov pa ytan
RES
ALTITUD

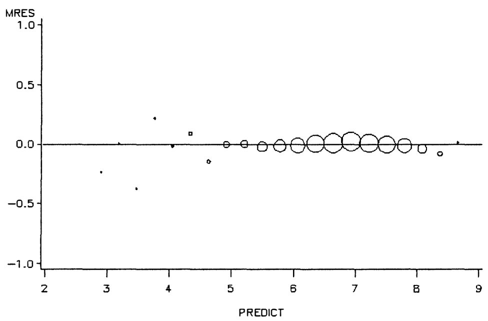

Logistisk regression om det finns minst 5 procent lov pa ytan
RES
ALDER

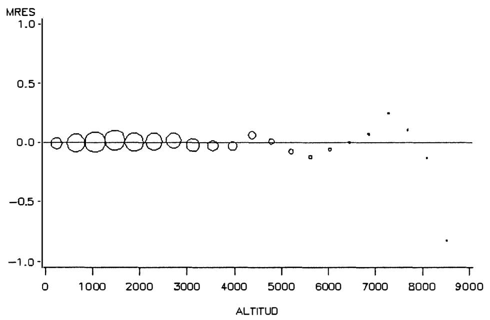

Logistisk regression om det finns minst 5 procent lov pa ytan
RES
VOLYMEN

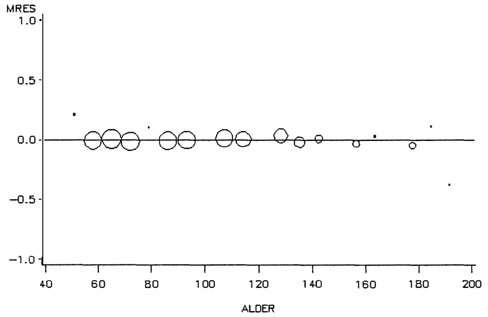

Logistisk regression om det finns minst 5 procent lov pa ytan
RES
BONIGR

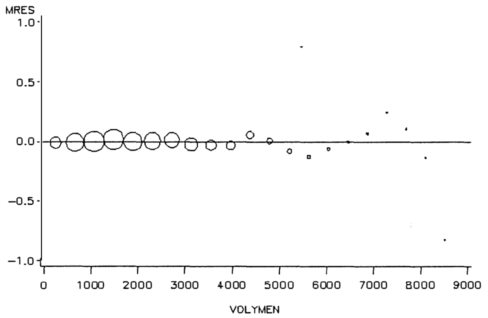
Resultat: ”Regression som skattar ***volym*** av tall om beståndsåldern är större än 45 år”.

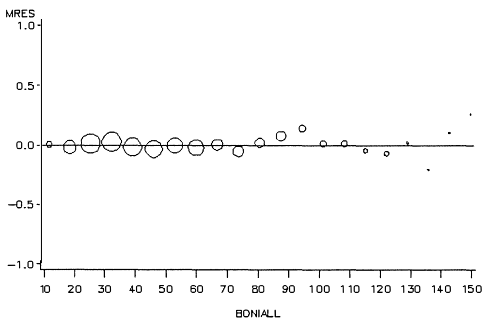
```
Model: MODEL1
Dependent Variable: VOLTALN

                          Analysis of Variance

                              Sum of         Mean
        Source          DF   Squares       Square       F Value       Prob>F

        Model            4  5104.94049   1276.23512     9694.088       0.0001
        Error         8312  1094.28199      0.13165
        C Total       8316  6199.22248

            Root MSE       0.36284     R-square        0.8235
            Dep Mean       6.76284     Adj R-sq        0.8234
            C.V.           5.36516

                          Parameter Estimates

                        Parameter       Standard     T for H0:
      Variable  DF       Estimate          Error   Parameter=0     Prob > |T|

      INTERCEP   1      -2.128175     0.05018028       -42.411         0.0001
      CON        1       0.939402     0.02277627        41.245         0.0001
      TALLDOM    1       1.201395     0.00915372       131.247         0.0001
      BESTALD    1       0.001480     0.00014307        10.346         0.0001
      VOLYMLN    1       0.947081     0.00592508       159.843         0.0001
```





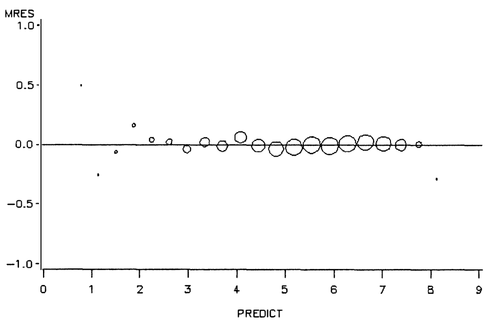

MRES
1.0
0.5
0.0
-0.5
-1.0
40
60
80
100
120
140
160
180
200
ALDER

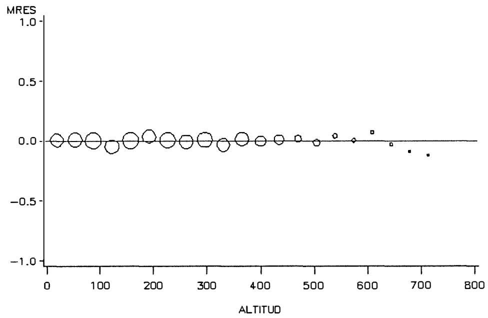

MRES
1.0
0.5
0.0
-0.5
-1.0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
VOLYMEN

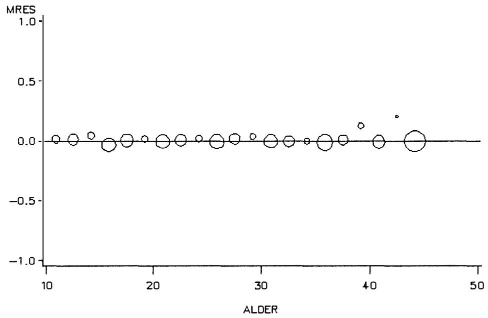

MRES
1.0
0.5
0.0
-0.5
-1.0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
BONIALL

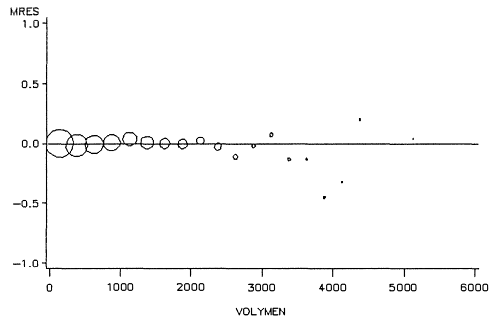
Resultat: ”Regression som skattar ***volym*** av tall om beståndsåldern är mindre än 45 år”.

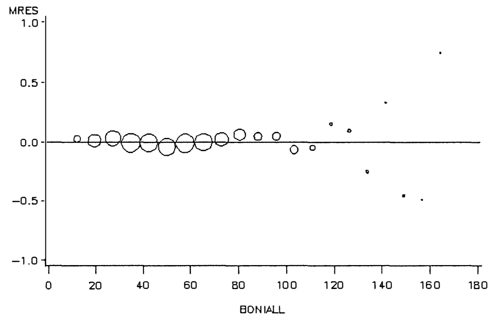
```
Model: MODEL1
Dependent Variable: VOLTALN

                           Analysis of Variance

                                 Sum of         Mean
        Source          DF      Squares       Square      F Value       Prob>F

        Model            7   8947.59114   1278.22731     9090.425       0.0001
        Error         5495    772.66567      0.14061
        C Total       5502   9720.25681

            Root MSE       0.37498     R-square       0.9205
            Dep Mean       5.45995     Adj R-sq       0.9204
            C.V.           6.86789

                           Parameter Estimates

                      Parameter       Standard     T for H0:
      Variable  DF     Estimate          Error   Parameter=0    Prob > |T|

      INTERCEP   1    -2.752852     0.05287984       -52.059        0.0001
      CON        1     1.147204     0.01708944        67.129        0.0001
      TALLDOM    1     1.248156     0.01479516        84.362        0.0001
      HOJDOH     1     0.000190     0.00004023         4.727        0.0001
      BESTALN    1     0.033987     0.01746546         1.946        0.0517
      BONALLA    1     0.003493     0.00090881         3.843        0.0001
      BONALL2    1  -0.000042431    0.00000691        -6.142        0.0001
      VOLYMLN    1     0.987911     0.00706570       139.818        0.0001
```




MRES
1.0
0.5
0.0
-0.5
-1.0
0
100
200
300
400
500
600
700
800
ALTITUD


MRES
1.0
0.5
0.0
-0.5
-1.0
10
20
30
40
50
ALDER


MRES
1.0
0.5
0.0
-0.5
-1.0
0
1000
2000
3000
4000
5000
6000
VOLYMEN


MRES
1.0
0.5
0.0
-0.5
-1.0
0
20
40
60
80
100
120
140
160
180
BONIALL

Resultat: ”Regression som skattar ***volym*** av gran om beståndsåldern är äldre än 65 år”.

```
Model: MODEL1
Dependent Variable: VOLGRLN
```

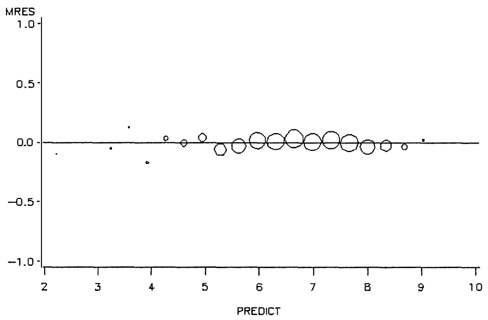
Analysis of Variance

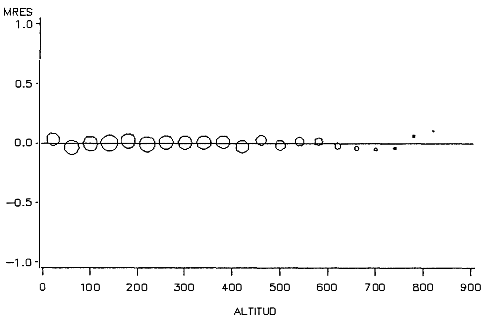
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	8	6468.69304	808.58663	4521.454	0.0001
Error	6698	1197.82548	0.17883		
C Total	6706	7666.51852			

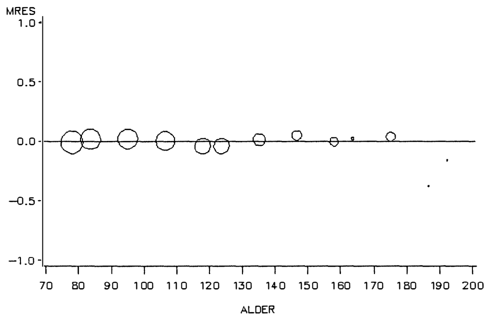
Root MSE	0.42289	R-square	0.8438
Dep Mean	6.72055	Adj R-sq	0.8436
C.V.	6.29244		

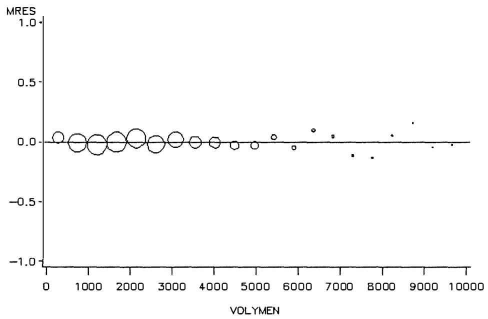
Parameter Estimates

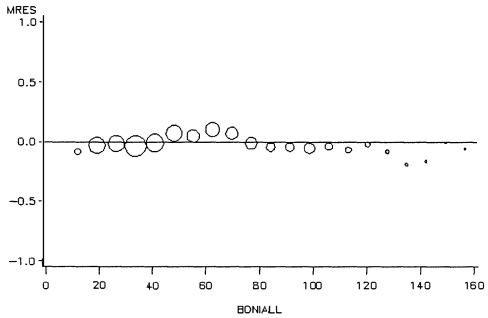
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-1.388445	0.13116238	-10.586	0.0001
CON	1	0.926356	0.02443714	37.908	0.0001
TALLDOM	1	-1.318703	0.01174249	-112.302	0.0001
HOJDOH	1	0.000435	0.00007272	5.981	0.0001
HOHLN	1	-0.033159	0.01173610	-2.825	0.0047
BESTALD	1	0.000536	0.00023447	2.288	0.0222
VOLYM	1	0.000016125	0.00000969	1.665	0.0960
VOLYMLN	1	1.009303	0.01844286	54.726	0.0001
BONALLA	1	0.001767	0.00028390	6.224	0.0001









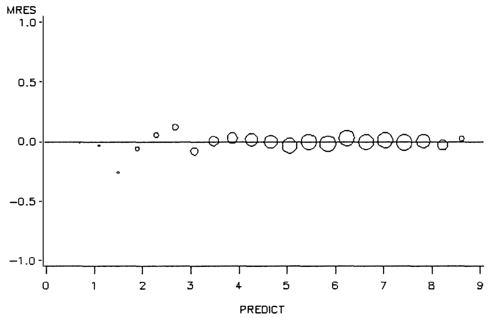


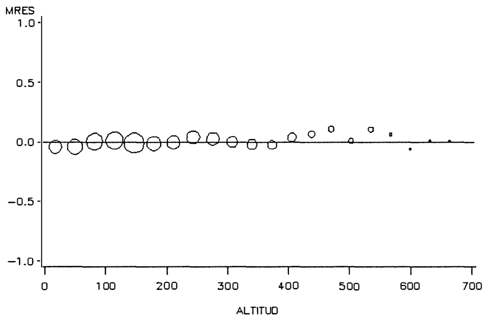
Resultat: ”Regression som skattar ***volym*** av gran om beståndsåldern är yngre än 65 år”.

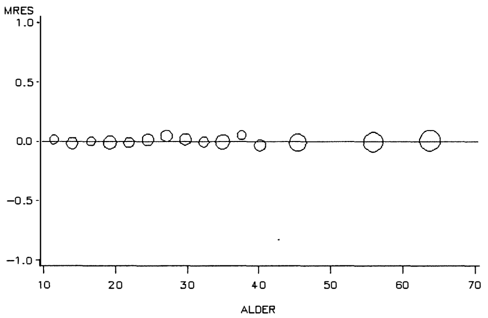
```
Model: MODEL1
Dependent Variable: VOLGRLN

                              Analysis of Variance

                                 Sum of         Mean
        Source          DF      Squares       Square      F Value        Prob>F

        Model            8  18251.54102   2281.44263    11527.383        0.0001
        Error         8206   1624.09089      0.19792
        C Total       8214  19875.63191

            Root MSE       0.44488     R-square       0.9183
            Dep Mean       5.84727     Adj R-sq       0.9182
            C.V.           7.60828
```

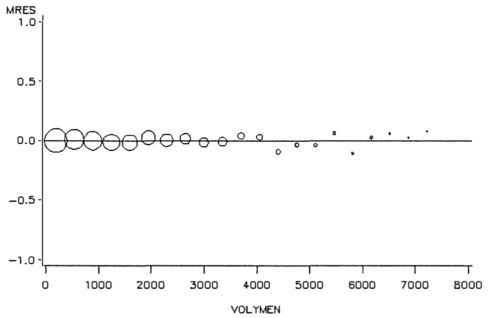
Parameter Estimates

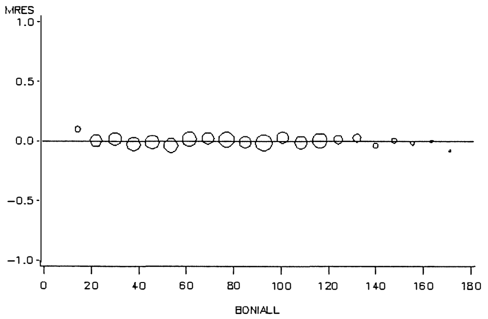
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-1.954778	0.11299914	-17.299	0.0001
CON	1	1.105695	0.01403687	78.771	0.0001
TALLDOM	1	-1.294712	0.01258190	-102.903	0.0001
BESTALD	1	-0.005059	0.00135262	-3.740	0.0002
BESTALN	1	0.260393	0.04979236	5.230	0.0001
VOLYM	1	0.000095158	0.00002355	4.040	0.0001
VOLYMLN	1	0.926058	0.01255758	73.745	0.0001
VOLYM2	1	-8.832456E-9	0.00000000	-2.560	0.0105
BONALLA	1	0.002805	0.00022012	12.742	0.0001








MRES
1.0
0.5
0.0
-0.5
-1.0
0
1000
2000
3000
4000
5000
6000
7000
8000
VOLYMEN


MRES
1.0
0.5
0.0
-0.5
-1.0
0
20
40
60
80
100
120
140
160
180
BONIALL

Resultat: ”Regression som skattar ***volym*** av löv om beståndsåldern är äldre än 55 år”.

```
Model: MODEL1
Dependent Variable: VOLLOLN
```

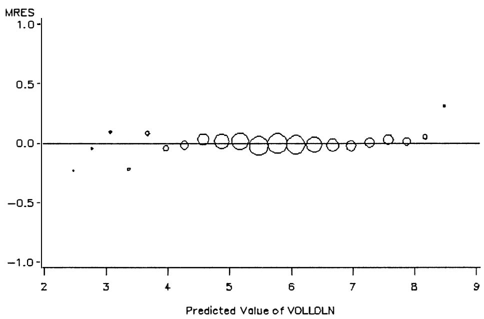
Analysis of Variance

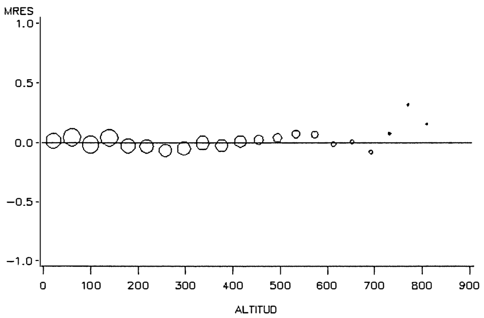
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	5	4864.05506	972.81101	3127.092	0.0001
Error	5722	1780.06414	0.31109		
C Total	5727	6644.11920			

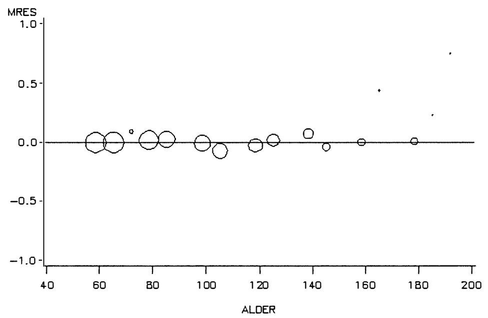
Root MSE	0.55776	R-square	0.7321
Dep Mean	5.81451	Adj R-sq	0.7319
C.V.	9.59248		

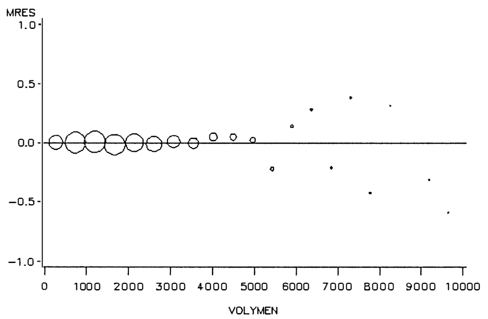
Parameter Estimates

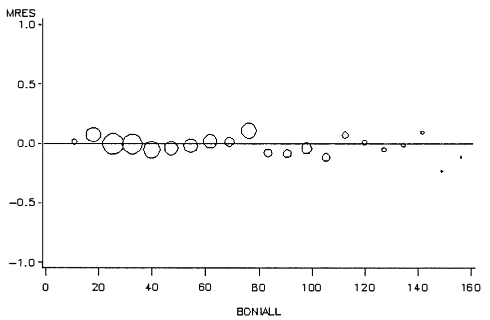
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.560538	0.07928988	7.069	0.0001
CON	1	-1.507456	0.01841203	-81.873	0.0001
TALLDOM	1	-0.116880	0.01546249	-7.559	0.0001
HOJDOH	1	-0.000238	0.00005239	-4.534	0.0001
BESTALD	1	-0.002253	0.00028307	-7.959	0.0001
VOLYMLN	1	0.925349	0.01017762	90.920	0.0001









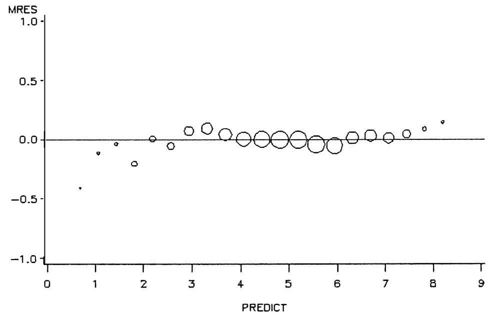


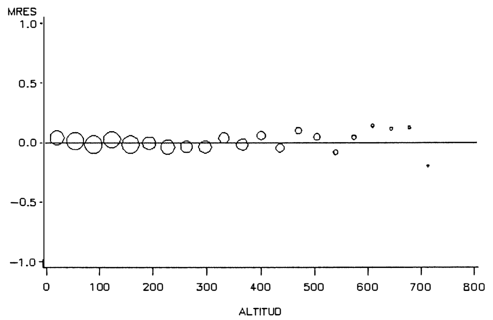
Resultat: ”Regression som skattar ***volym*** av löv om beståndsåldern är yngre än 55 år”.

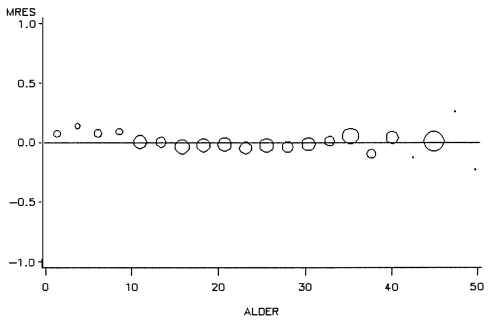
```
Model: MODEL1
Dependent Variable: VOLLOLN

                               Analysis of Variance

                                   Sum of          Mean
        Source          DF        Squares        Square       F Value        Prob>F

        Model            5     8743.95810    1748.79162      6861.936        0.0001
        Error         5022     1279.87654       0.25485
        C Total       5027    10023.83463

            Root MSE       0.50483     R-square       0.8723
            Dep Mean       4.97789     Adj R-sq       0.8722
            C.V.          10.14146
```

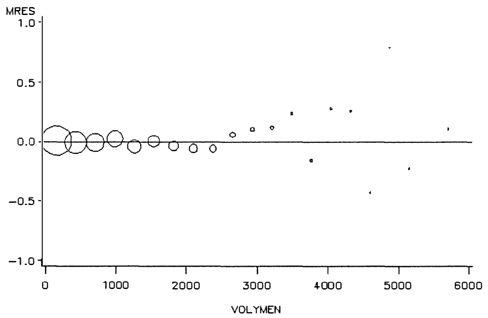
Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.392643	0.08374564	4.689	0.0001
CON	1	-1.467991	0.01455502	-100.858	0.0001
TALLDOM	1	-0.063037	0.01586331	-3.974	0.0001
HOJDOH	1	-0.000279	0.00006055	-4.614	0.0001
VOLYMLN	1	0.976747	0.00643673	151.746	0.0001
BONALLN	1	-0.097216	0.01830086	-5.312	0.0001

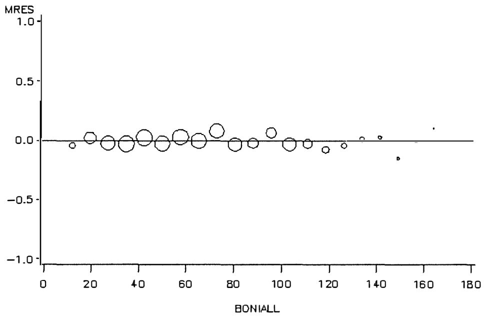








MRES
1.0
0.5
0.0
-0.5
-1.0
0
1000
2000
3000
4000
5000
6000
VOLYMEN



MRES
1.0
0.5
0.0
-0.5
-1.0
0
20
40
60
80
100
120
140
160
180
BONIALL

Appendix 5

991116

SMAC

— funktioner för att skatta beståndsdiametrar —

SMAC — funktioner för att skatta beståndsdiametrar

Funktioner utvecklades för att skatta grundytemedelstammens-, grundytevägd-, samt aritmetisk medeldiameter. Dessa beräknades som:

$$d_{grundytemedelstammen} = \sqrt{\frac{\sum d^2}{n}} \quad [1]; \quad d_{gv} = \frac{\sum d^3}{\sum d^2} \quad [2]; \quad \bar{d} = \frac{\sum d}{n} \quad [3]$$

Variablerna hämtades från RTs tillfälliga skogsmarksytor för åren 1993-1998. Av prediktionstekniska skäl användes endast odelade ytor (15394 dm^2 stora) och levande klavträd större än 4 cm i brh. Klavträd större än 10 cm insamlas på en provyta med radie 7 meter medan klavträd 4-9,99 cm insamlas med radie 3,5 meter. Detta innebär att en vikt som är 1 för stora träd och 4 för små träd placerades innanför varje summatecken i formel 1-3.

Som oberoende variabler användes höjd över havet *hojdoh* (m), breddgrad *bredgra* (10-dels grader), subjektivt mätt totalålder *bestald* (år), tallbonitet om tallens volym är större än granens *tabon* (10-dels m^3sk per ha och år) annars granbonitet *grbon*, om barrträd dominerar volymmässigt och tallvolymen är större än granvolymen är *talldom* =1, och motsvarande för gran, *grandomi*. Om övriga trädslag dominerar är både *talldom* och *grandomi* noll. *Volym* (10-dels m^3sk per ha) är total volym.

Variabler har testats var för sig, ibland kombinerade, transformerade mm. Stor vikt har lagts vid att utifrån data få linjära samband mellan beroende och oberoende variabler i tvådimensionell form. Modellen har utifrån dessa tvådimensionella samband successivt byggts upp. Studier av medelresidualer plottade mot använda och mot övriga intressanta variabler har gjorts. Om variabelnamnet avslutas med ln innebär detta att variabeln logaritmerats med naturliga logaritmen. Således har den beroende variabeln logaritmerats — dvs en multiplikativ modell har använts. Vid eventuell återtransformering kan korrigering för logaritmisk bias göras med kvadraten på spridningen kring funktionen (Root MSE) delat med två.
Latalt=hojdoh×bredgra.

Funktionerna som skattar GYTEMELN och DGVLN verkar prediktera likvärdigt medan ARITMLN funktionen tycks prediktera sämre.

Dependent Variable: GYTEMELN

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	1258.87250	125.88725	4187.461	0.0001
Error	22106	664.57055	0.03006		
C Total	22116	1923.44305			

Root MSE	0.17339	R-square	0.6545
Dep Mean	5.15822	Adj R-sq	0.6543
C.V.	3.36136		

Parameter Variable	DF	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	5.655491	0.05279733	107.117	0.0001
LATALT	1	0.000005745	0.00000033	17.412	0.0001
HOJDOH	1	-0.003588	0.00020492	-17.509	0.0001
BREDGRA	1	-0.002164	0.00008188	-26.428	0.0001
BESTALD	1	0.002718	0.00004294	63.285	0.0001
TABON	1	0.001719	0.00010629	16.174	0.0001
GRBON	1	0.000782	0.00007036	11.108	0.0001
TALLDOMI	1	0.040746	0.00398460	10.226	0.0001
GRANDOMI	1	0.018672	0.00420650	4.439	0.0001
VOLYMLN	1	0.066911	0.00197364	33.902	0.0001
VOLYM	1	0.000065000	0.00000173	37.676	0.0001

Analysis Variable : PRE Predicted Value of GYTEMELN

N	Minimum	Maximum
22117	4.5002992	6.0577011

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	278	22117	4.50030	6.05770	4.57817	278	0.01597	0.026306		1
2	0	1477	22117	4.50030	6.05770	4.73391	1477	0.01398	0.035709		6
3	0	2742	22117	4.50030	6.05770	4.88965	2742	-0.01407	0.024244		12
4	0	4115	22117	4.50030	6.05770	5.04539	4115	-0.04510	0.022868		18
5	0	5888	22117	4.50030	6.05770	5.20113	5888	-0.02436	0.030687		26
6	0	5041	22117	4.50030	6.05770	5.35687	5041	0.00847	0.034257		22
7	0	2045	22117	4.50030	6.05770	5.51261	2045	0.01965	0.033516		9
8	0	467	22117	4.50030	6.05770	5.66835	467	-0.00702	0.032946		2
9	0	55	22117	4.50030	6.05770	5.82409	55	-0.05623	0.035340		0
10	0	9	22117	4.50030	6.05770	5.97983	9	-0.13002	0.080364		0

Analysis Variable : HOJDOH Höjd över havet

N	Minimum	Maximum
22117	0	840.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	4598	22117	0	840	42	4598	-0.009804	0.033722		20
2	0	5170	22117	0	840	126	5170	-0.008211	0.033457		23
3	0	4282	22117	0	840	210	4282	-0.008582	0.029131		19
4	0	3110	22117	0	840	294	3110	-0.025374	0.027153		14
5	0	2322	22117	0	840	378	2322	-0.035493	0.024589		10
6	0	1491	22117	0	840	462	1491	-0.011155	0.025585		6
7	0	702	22117	0	840	546	702	0.007207	0.028049		3
8	0	319	22117	0	840	630	319	0.058444	0.032203		1
9	0	98	22117	0	840	714	98	0.096466	0.030977		0
10	0	25	22117	0	840	798	25	0.075495	0.038159		0

Analysis Variable : BREDGRA Breddgrad

N	Minimum	Maximum
22117	554.0000000	683.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	1894	22117	554	683	560.45	1894	-0.032296	0.037048		8
2	0	3390	22117	554	683	573.35	3390	0.001537	0.034802		15
3	0	2413	22117	554	683	586.25	2413	0.000275	0.036750		10
4	0	3449	22117	554	683	599.15	3449	-0.010845	0.029995		15
5	0	2619	22117	554	683	612.05	2619	-0.017173	0.027259		11
6	0	2005	22117	554	683	624.95	2005	-0.032988	0.027412		9
7	0	2503	22117	554	683	637.85	2503	-0.031396	0.025190		11
8	0	1745	22117	554	683	650.75	1745	-0.012213	0.023971		7
9	0	1608	22117	554	683	663.65	1608	0.012409	0.024922		7
10	0	491	22117	554	683	676.55	491	0.033741	0.029207		2

Analysis Variable : BESTALD Beståndsålder

N	Minimum	Maximum
22117	1.0000000	315.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	5731	22117	1	315	16.7	5731	-0.04944	0.03088		25
2	0	5273	22117	1	315	48.1	5273	-0.02457	0.02347		23
3	0	6413	22117	1	315	79.5	6413	0.03302	0.02942		28
4	0	3218	22117	1	315	110.9	3218	-0.00254	0.03328		14
5	0	1165	22117	1	315	142.3	1165	-0.03530	0.03334		5
6	0	301	22117	1	315	173.7	301	-0.04536	0.03936		1
7	0	11	22117	1	315	205.1	11	-0.13761	0.04312		0
8	0	1	22117	1	315	236.5	1	-0.37371	.		0
9	0	2	22117	1	315	267.9	2	-0.34027	0.10300		0
10	0	2	22117	1	315	299.3	2	-0.27039	0.02344		0

Analysis Variable : TABON

N	Minimum	Maximum
22117	0	123.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	10759	22117	0	123	6.15	10759	-0.00783	0.029094		48
2	0	1295	22117	0	123	18.45	1295	0.00692	0.031162		5
3	0	2838	22117	0	123	30.75	2838	-0.00307	0.027616		12
4	0	2565	22117	0	123	43.05	2565	-0.01645	0.027493		11
5	0	2016	22117	0	123	55.35	2016	-0.02554	0.032968		9
6	0	2161	22117	0	123	67.65	2161	-0.03082	0.038503		9
7	0	359	22117	0	123	79.95	359	-0.03734	0.037131		1
8	0	107	22117	0	123	92.25	107	-0.07723	0.025639		0
9	0	16	22117	0	123	104.55	16	-0.06698	0.045703		0
10	0	1	22117	0	123	116.85	1	-0.20063	.		0

Analysis Variable : GRBON

N	Minimum	Maximum
22117	0	175.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	11561	22117	0	175	8.75	11561	-0.016133	0.031460		52
2	0	2194	22117	0	175	26.25	2194	-0.025745	0.025070		9
3	0	1632	22117	0	175	43.75	1632	-0.018656	0.026096		7
4	0	1186	22117	0	175	61.25	1186	0.000457	0.026030		5
5	0	1488	22117	0	175	78.75	1488	0.009971	0.026790		6
6	0	1812	22117	0	175	96.25	1812	0.007597	0.031232		8
7	0	1497	22117	0	175	113.75	1497	-0.008036	0.037239		6
8	0	576	22117	0	175	131.25	576	-0.024660	0.033219		2
9	0	135	22117	0	175	148.75	135	0.016013	0.034311		0
10	0	36	22117	0	175	166.25	36	0.032892	0.023771		0

Analysis Variable : VOLYM

N	Minimum	Maximum
22117	6.0000000	9879.00

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	9241	22117	6	9879	499.65	9241	-0.017586	0.028897		41
2	0	6393	22117	6	9879	1486.95	6393	-0.017433	0.029724		28
3	0	3706	22117	6	9879	2474.25	3706	-0.001469	0.032623		16
4	0	1679	22117	6	9879	3461.55	1679	0.009479	0.032124		7
5	0	703	22117	6	9879	4448.85	703	0.003270	0.034911		3
6	0	244	22117	6	9879	5436.15	244	-0.000060	0.033726		1
7	0	105	22117	6	9879	6423.45	105	-0.028462	0.030961		0
8	0	31	22117	6	9879	7410.75	31	-0.064278	0.029377		0
9	0	11	22117	6	9879	8398.05	11	-0.061856	0.061721		0
10	0	4	22117	6	9879	9385.35	4	-0.080304	0.022204		0

Dependent Variable: DGVLN

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	3787.51587	378.75159	5415.565	0.0001
Error	22153	1549.32766	0.06994		
C Total	22163	5336.84353			

Root MSE	0.26446	R-square	0.7097
Dep Mean	5.14181	Adj R-sq	0.7096
C.V.	5.14327		

Parameter Variable	DF	Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	5.272716	0.08044924	65.541	0.0001
LATALT	1	0.000010893	0.00000050	21.671	0.0001
HOJDOH	1	-0.006758	0.00031218	-21.648	0.0001
BREDGRA	1	-0.003492	0.00012476	-27.987	0.0001
BESTALD	1	0.004083	0.00006507	62.755	0.0001
TABON	1	0.002173	0.00016161	13.445	0.0001
GRBON	1	0.000754	0.00010705	7.043	0.0001
TALLDOMI	1	0.062817	0.00606576	10.356	0.0001
GRANDOMI	1	0.042570	0.00642040	6.630	0.0001
VOLYMLN	1	0.230078	0.00300906	76.462	0.0001
VOLYM	1	0.000020608	0.00000263	7.835	0.0001

Analysis Variable : PRE Predicted Value of DGVLN

N	Minimum	Maximum
22164	3.6984733	6.2575087

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	87	22164	3.69847	6.25751	3.82643	87	0.066450	0.08846		0
2	0	468	22164	3.69847	6.25751	4.08233	468	0.038509	0.14029		2
3	0	1098	22164	3.69847	6.25751	4.33823	1098	-0.042955	0.13306		4
4	0	1798	22164	3.69847	6.25751	4.59414	1798	-0.052427	0.11603		8
5	0	2762	22164	3.69847	6.25751	4.85004	2762	-0.048484	0.09142		12
6	0	4908	22164	3.69847	6.25751	5.10594	4908	-0.013190	0.06794		22
7	0	6596	22164	3.69847	6.25751	5.36185	6596	0.008994	0.05272		29
8	0	3859	22164	3.69847	6.25751	5.61775	3859	0.005084	0.04162		17
9	0	572	22164	3.69847	6.25751	5.87365	572	-0.044115	0.03861		2
10	0	16	22164	3.69847	6.25751	6.12956	16	-0.095040	0.10143		0

Analysis Variable : HOJDOH Höjd över havet

N	Minimum	Maximum
22164	0	840.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	4614	22164	0	840	42	4614	-0.00258	0.072329		20
2	0	5197	22164	0	840	126	5197	-0.00178	0.071663		23
3	0	4289	22164	0	840	210	4289	-0.00882	0.069994		19
4	0	3109	22164	0	840	294	3109	-0.04646	0.065303		14
5	0	2321	22164	0	840	378	2321	-0.04357	0.066305		10
6	0	1491	22164	0	840	462	1491	-0.01129	0.066854		6
7	0	704	22164	0	840	546	704	0.02645	0.073593		3
8	0	318	22164	0	840	630	318	0.07533	0.075684		1
9	0	96	22164	0	840	714	96	0.12970	0.072037		0
10	0	25	22164	0	840	798	25	0.09099	0.065828		0

Analysis Variable : BREDGRA Breddgrad

N	Minimum	Maximum
22164	554.0000000	683.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	1916	22164	554	683	560.45	1916	-0.020323	0.074016		8
2	0	3398	22164	554	683	573.35	3398	0.011399	0.074376		15
3	0	2425	22164	554	683	586.25	2425	0.007111	0.081125		10
4	0	3458	22164	554	683	599.15	3458	-0.016453	0.068987		15
5	0	2619	22164	554	683	612.05	2619	-0.020657	0.066039		11
6	0	2004	22164	554	683	624.95	2004	-0.046268	0.066929		9
7	0	2505	22164	554	683	637.85	2505	-0.046320	0.065613		11
8	0	1744	22164	554	683	650.75	1744	-0.011008	0.059056		7
9	0	1606	22164	554	683	663.65	1606	0.016712	0.064331		7
10	0	489	22164	554	683	676.55	489	0.063360	0.081675		2

Analysis Variable : BESTALD Beståndsålder

N	Minimum	Maximum
22164	1.0000000	315.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	5719	22164	1	315	16.7	5719	-0.09514	0.11330		25
2	0	5277	22164	1	315	48.1	5277	0.00839	0.05536		23
3	0	6448	22164	1	315	79.5	6448	0.05964	0.04597		29
4	0	3232	22164	1	315	110.9	3232	-0.01192	0.05017		14
5	0	1171	22164	1	315	142.3	1171	-0.06555	0.05287		5
6	0	301	22164	1	315	173.7	301	-0.09359	0.05422		1
7	0	11	22164	1	315	205.1	11	-0.25372	0.05557		0
8	0	1	22164	1	315	236.5	1	-0.54010	.		0
9	0	2	22164	1	315	267.9	2	-0.56989	0.08338		0
10	0	2	22164	1	315	299.3	2	-0.47006	0.04668		0

Analysis Variable : TABON

N	Minimum	Maximum
22164	0	123.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	10771	22164	0	123	6.15	10771	-0.01002	0.067404		48
2	0	1291	22164	0	123	18.45	1291	0.02991	0.082977		5
3	0	2841	22164	0	123	30.75	2841	-0.00667	0.068672		12
4	0	2569	22164	0	123	43.05	2569	-0.02132	0.064063		11
5	0	2027	22164	0	123	55.35	2027	-0.02289	0.075267		9
6	0	2176	22164	0	123	67.65	2176	-0.02362	0.085308		9
7	0	365	22164	0	123	79.95	365	-0.03712	0.056651		1
8	0	107	22164	0	123	92.25	107	-0.07891	0.031621		0
9	0	16	22164	0	123	104.55	16	-0.06826	0.059940		0
10	0	1	22164	0	123	116.85	1	-0.17489	.		0

Analysis Variable : GRBON

N	Minimum	Maximum
22164	0	175.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	11596	22164	0	175	8.75	11596	-0.013906	0.073134		52
2	0	2193	22164	0	175	26.25	2193	-0.037523	0.065127		9
3	0	1628	22164	0	175	43.75	1628	-0.026975	0.063876		7
4	0	1187	22164	0	175	61.25	1187	-0.000976	0.058318		5
5	0	1492	22164	0	175	78.75	1492	0.009857	0.065497		6
6	0	1815	22164	0	175	96.25	1815	0.012685	0.071509		8
7	0	1500	22164	0	175	113.75	1500	-0.010174	0.080258		6
8	0	580	22164	0	175	131.25	580	-0.011195	0.061208		2
9	0	137	22164	0	175	148.75	137	0.045734	0.050608		0
10	0	36	22164	0	175	166.25	36	0.063491	0.030390		0

Analysis Variable : VOLYM

N	Minimum	Maximum
22164	6.0000000	9879.00

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	9226	22164	6	9879	499.65	9226	-0.021444	0.097889		41
2	0	6429	22164	6	9879	1486.95	6429	-0.010139	0.056322		29
3	0	3726	22164	6	9879	2474.25	3726	-0.002819	0.048307		16
4	0	1683	22164	6	9879	3461.55	1683	0.006164	0.040533		7
5	0	704	22164	6	9879	4448.85	704	-0.002616	0.041549		3
6	0	245	22164	6	9879	5436.15	245	0.013847	0.040538		1
7	0	105	22164	6	9879	6423.45	105	-0.014818	0.034138		0
8	0	31	22164	6	9879	7410.75	31	-0.029538	0.021835		0
9	0	11	22164	6	9879	8398.05	11	0.006409	0.089517		0
10	0	4	22164	6	9879	9385.35	4	-0.018263	0.010597		0

Dependent Variable: ARITMLN

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	8	225.37730	28.17216	884.343	0.0001
Error	22196	707.08939	0.03186		
C Total	22204	932.46669			

Root MSE	0.17848	R-square	0.2417
Dep Mean	5.30077	Adj R-sq	0.2414
C.V.	3.36714		

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	6.305691	0.05392298	116.939	0.0001
LATALT	1	0.000002802	0.00000034	8.345	0.0001
HOJDOH	1	-0.001802	0.00020848	-8.644	0.0001
BREDGRA	1	-0.001401	0.00008325	-16.832	0.0001
BESTALD	1	0.001314	0.00004358	30.145	0.0001
TABON	1	0.000887	0.00010038	8.837	0.0001
GRBON	1	0.000238	0.00006970	3.415	0.0006
VOLYMLN	1	-0.055902	0.00205692	-27.178	0.0001
VOLYM	1	0.000087231	0.00000178	48.941	0.0001

Analysis Variable : PRE Predicted Value of ARITMLN

N	Minimum	Maximum
22205	5.1119470	5.9465335

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	2046	22205	5.11195	5.94653	5.15368	2046	0.06999	0.038247		9
2	0	8146	22205	5.11195	5.94653	5.23713	8146	-0.01940	0.033712		36
3	0	6689	22205	5.11195	5.94653	5.32059	6689	-0.03172	0.027572		30
4	0	3327	22205	5.11195	5.94653	5.40405	3327	0.01679	0.027437		14
5	0	1291	22205	5.11195	5.94653	5.48751	1291	0.03633	0.028283		5
6	0	468	22205	5.11195	5.94653	5.57097	468	0.02779	0.030545		2
7	0	175	22205	5.11195	5.94653	5.65443	175	-0.01031	0.030913		0
8	0	40	22205	5.11195	5.94653	5.73789	40	-0.01766	0.031797		0
9	0	14	22205	5.11195	5.94653	5.82135	14	-0.07246	0.024785		0
10	0	9	22205	5.11195	5.94653	5.90480	9	-0.14222	0.064588		0

Analysis Variable : HOJDOH Höjd över havet

N	Minimum	Maximum
22205	0	830.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	4624	22205	0	830	41.5	4624	-0.005289	0.032214		20
2	0	5176	22205	0	830	124.5	5176	-0.004223	0.031964		23
3	0	3840	22205	0	830	207.5	3840	-0.004959	0.031000		17
4	0	3592	22205	0	830	290.5	3592	-0.003177	0.031008		16
5	0	2327	22205	0	830	373.5	2327	-0.021542	0.030949		10
6	0	1367	22205	0	830	456.5	1367	-0.005025	0.032221		6
7	0	839	22205	0	830	539.5	839	-0.001837	0.034884		3
8	0	289	22205	0	830	622.5	289	0.036977	0.041309		1
9	0	122	22205	0	830	705.5	122	0.054527	0.040864		0
10	0	29	22205	0	830	788.5	29	0.065858	0.023053		0

Analysis Variable : BREDGRA Breddgrad

N	Minimum	Maximum
22205	554.0000000	683.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	1899	22205	554	683	560.45	1899	-0.026774	0.035021		8
2	0	3403	22205	554	683	573.35	3403	0.002027	0.032499		15
3	0	2421	22205	554	683	586.25	2421	0.005458	0.033282		10
4	0	3476	22205	554	683	599.15	3476	0.001278	0.032338		15
5	0	2632	22205	554	683	612.05	2632	-0.012326	0.030006		11
6	0	2003	22205	554	683	624.95	2003	-0.013340	0.031325		9
7	0	2516	22205	554	683	637.85	2516	-0.017037	0.028974		11
8	0	1750	22205	554	683	650.75	1750	-0.011785	0.029866		7
9	0	1606	22205	554	683	663.65	1606	0.014946	0.031293		7
10	0	499	22205	554	683	676.55	499	0.017796	0.038427		2

Analysis Variable : BESTALD Beståndsålder

N	Minimum	Maximum
22205	1.0000000	315.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	5807	22205	1	315	16.7	5807	0.01205	0.046903		26
2	0	5277	22205	1	315	48.1	5277	-0.05656	0.024800		23
3	0	6420	22205	1	315	79.5	6420	0.01408	0.024669		28
4	0	3218	22205	1	315	110.9	3218	0.00879	0.026781		14
5	0	1167	22205	1	315	142.3	1167	-0.00425	0.026859		5
6	0	300	22205	1	315	173.7	300	-0.00151	0.036623		1
7	0	11	22205	1	315	205.1	11	0.00169	0.031283		0
8	0	1	22205	1	315	236.5	1	-0.17923	.		0
9	0	2	22205	1	315	267.9	2	-0.20961	0.094939		0
10	0	2	22205	1	315	299.3	2	-0.14623	0.006731		0

Analysis Variable : TABON

N	Minimum	Maximum
22205	0	123.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	10754	22205	0	123	6.15	10754	-0.00311	0.029188		48
2	0	1302	22205	0	123	18.45	1302	-0.01371	0.035930		5
3	0	2858	22205	0	123	30.75	2858	0.00415	0.033777		12
4	0	2587	22205	0	123	43.05	2587	0.00010	0.032708		11
5	0	2039	22205	0	123	55.35	2039	-0.01039	0.034893		9
6	0	2183	22205	0	123	67.65	2183	-0.01418	0.035938		9
7	0	358	22205	0	123	79.95	358	-0.03903	0.035821		1
8	0	107	22205	0	123	92.25	107	-0.08946	0.025906		0
9	0	16	22205	0	123	104.55	16	-0.06508	0.032415		0
10	0	1	22205	0	123	116.85	1	-0.13204	.		0

Analysis Variable : GRBON

N	Minimum	Maximum
22205	0	175.0000000

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	11656	22205	0	175	8.75	11656	-0.007360	0.034549		52
2	0	2191	22205	0	175	26.25	2191	-0.012989	0.028016		9
3	0	1628	22205	0	175	43.75	1628	-0.007592	0.026234		7
4	0	1186	22205	0	175	61.25	1186	-0.001897	0.027202		5
5	0	1492	22205	0	175	78.75	1492	0.012947	0.026193		6
6	0	1811	22205	0	175	96.25	1811	0.008624	0.030507		8
7	0	1494	22205	0	175	113.75	1494	-0.000999	0.034374		6
8	0	576	22205	0	175	131.25	576	-0.034626	0.030994		2
9	0	135	22205	0	175	148.75	135	-0.007730	0.032210		0
10	0	36	22205	0	175	166.25	36	0.009447	0.026266		0

Analysis Variable : VOLYM

N	Minimum	Maximum
22205	6.0000000	9879.00

OBS	_TYPE_	_FREQ_	TOTANT	XMIN	XMAX	PREDDIS	ANTAL	MRES	VRES	RELA	REL
1	0	9310	22205	6	9879	499.65	9310	-0.000970	0.040688		41
2	0	6411	22205	6	9879	1486.95	6411	-0.021615	0.024348		28
3	0	3708	22205	6	9879	2474.25	3708	0.003035	0.025688		16
4	0	1677	22205	6	9879	3461.55	1677	0.011127	0.025960		7
5	0	703	22205	6	9879	4448.85	703	0.010826	0.029374		3
6	0	245	22205	6	9879	5436.15	245	0.003846	0.030428		1
7	0	105	22205	6	9879	6423.45	105	-0.032334	0.028623		0
8	0	31	22205	6	9879	7410.75	31	-0.071117	0.027695		0
9	0	11	22205	6	9879	8398.05	11	-0.087766	0.055055		0
10	0	4	22205	6	9879	9385.35	4	-0.089319	0.029234		0

Filer på abies /home/hpe/mitt

Smacytor.sas ⇒ smacytor.ssd04 (ar, trakt, palslag)-data n =90705

Smacklav.sas ⇒ smacklav.ssd04 n =740935 klavträdsdata
smacklaB.ssd04 n =518242 döda bort (trädslag>100)
Viktsma=4 för träd 40-99.9 mm annars 1
Träd mindre än 40 mm bort

Summor.sas ⇒ summor.sas n =46168 beräkning av beroende variabler

Smackla3.sas ⇒ "merging" smacytor.ssd04+summor.ssd04 ⇒ smacdata.ssd04 n =90705; endast hela ytor (delavhel=15394), null för beroende bort: smacdat2.ssd04 n =22769

Regressioner görs med:
Smacgyte.sas; smacdgv.sas; smacarit.sas

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 samt internationellt. Författarna svarar själva för rapporternas vetenskapliga innehåll.

This series of Working Papers reflects the activity of this Department of Forest Resource Management and Geomatics. The sole responsibility for the scientific content of each Working Paper relies on the respective author.

Riksskogstaxeringen: (*The Swedish National Forest Inventory*)

1995 1 Kempe, G. Hjälpmedel för bestämning av slutenhet i plant- och ungskog. ISRN SLU-SRG-AR--1--SE

2 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, G. & 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 edge 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 Riksskogstaxeringen inför 2000-talet. - Utredningar avseende innehåll och omfattning i en framtida Riksskogstaxering. Redaktörer: Jonas Fridman & Göran Ståhl. ISRN SLU-SRG-AR--52--SE.

54 Fridman, J. m.fl. 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.

1999 61 Broman, N & Christoffersson, J. Mätfel i provträdsvariabler och dess inverkan på precision och noggrannhet i volymskattningar. ISRN SLU-SRG-AR--61--SE.

65 Hallsby, G m.fl. 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

Inventering och planering: ***(Forest inventory and planning)***

1995 3 Holmgren, P. & Thuresson, T. Skoglig planering på amerikanska västkusten - intryck från en studieresa till Oregon, Washington och British Columbia 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. A sequential approach in mathematical 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-SRGL-AR--19--SE.

25 Lämås, T. & Ståhl, G. Skattning av tillstånd och förändringar genom inventerings-simulering - En handledning till programpaketet "NVSIM". ISRN SLU-SRG-AR--25--SE.

26 Lämås, T. & Ståhl, G. Om dektering 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. & Löfgren, P. 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--79--SE.

2002 91 Wilhelmsson, E. Forest use and its economic value for inhabitants of Skröven and Hakkas in Norrbotten. ISRN SLU-SRG-AR--91--SE.

94 Eriksson, O. m fl. Wood Supply From Swedish Forests Managed According to the FSC-standard. ISRN SLU-SRG-AR--94--SE.

Biometri: ***(Biometrics)***

1997 22 Ali, Abdul Aziz. 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.

Fjärranalys: ***(Remote Sensing)***

1997 28 Hagner, O. Satellitfjärranalys för skogsföretag. ISRN SLU-SRG-AR--28--SE.

29 Hagner, O. Textur till flygbilder för skattning 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--28--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 Non-Timber Forest Resources - A literature survey. ISRN SLU-SRG-AR--66--SE.

69 Tingelöf, U & Nilsson, M.Kartering av hyggeskanter i pankromaötiska 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.

Kompendier och undervisningsmaterial: ***(Compendia and educational papers)***

1996 14 Holm, S. & Thuresson, T. samt jägm.studenter kurs 92/96. En analys av skogstill-ståndet samt några alternativa avverkningsberäkningar för en del av Östads säteri. ISRN SLU-SRG-AR--14--SE.

21 Holm, S. & Thuresson, T. samt jägm.studenter kurs 93/97. En analys av skogsstill-ståndet 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 93/97. 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. samt studenter vid Sveriges lantbruksuniversitet i samband med kurs i strategisk och taktisk skoglig planering år 1998. En analys av skogsstillståndet samt några alternativa avverknings beräkningar 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..

2002 93 Lind, T. (Ed.) Strategier för Östads säteri: Redovisning av planer framtagna under kursen Skoglig planering ur ett företagsperspektiv HT2001, SLU Umeå. ISRN SLU-SRG-AR--93--SE..

Examensarbeten: ***(Theses by Swedish forestry students)***

1995 5 Törnquist, K. Ekologisk landskapsplanering i svenskt skogsbruk - hur började det?. Examensarbete i ämnet skogsuppskattning och skogsindelning. ISRN SLU-SRG-AR--5--SE.

1996 6 Persson, S. & Segner, U. Aspekter kring datakvalitėns betydelse för den kortsiktiga planeringen. Examensarbete i ämnet skogsuppskattning och skogsindelning. 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? Examensarbete i ämnet skogsuppskattning och skogsindelning. ISRN SLU-SRG-AR--7--SE.

8 Ranvald, C. Sortimentsinriktad avverkning. Examensarbete i ämnet skogsuppskattning och skogsindelning. ISRN SLU-SRG-AR--8--SE.

9 Olofsson, C. Mångbruk i ett landskapsperspektiv - En fallstudie på MoDo Skog AB, Örnsköldsviks förvaltning. Examensarbete i ämnet skogsuppskattning och skogs-indelning. ISRN SLU-SRG-AR--9--SE.

10 Andersson, H. Taper curve functions and quality estimation for Common Oak (Quercus Robur L.) in Sweden. Examensarbete i ämnet skogsuppskattning och skogsuppskattning och skogsindelning. 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. Examensarbete i ämnet skogsuppskattning och skogsindelning. ISRN SLU-SRG-AR--11--SE.

12 Bredberg, J. Skattning av ålder och andra beståndsvariabler - en fallstudie baserad på MoDo:s indelningsrutiner. Examensarbete i ämnet skogsuppskattning och skogsindelning. ISRN SLU-SRG-AR--12--SE.

13 Gunnarsson, F. On the potential of Kriging for forest management planning. Examensarbete i ämnet skogsuppskattning och skogsindelning. ISRN SLU-SRG-AR--13--SE.

16 Tormalm, K. Implementering av FSC-certififering av mindre enskilda markägares skogsbruk. Examensarbete i ämnet skogsuppskattning och skogsindelning. 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 arbetsomsåde, SCA. Examensarbete i ämnet skogsuppskattning och skogsindelning. ISRN-SLU-SRG-AR--17--SE.

20 Cedervind, J. GPS under krontak i skog. Examensarbete i ämnet skogsuppskattning och skogsindelning. ISRN SLU-SRG-AR--20--SE.

27 Karlsson, A. En studie av tre inventeringsmetoder i slutavverkningsbestånd. Examensarbete. 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. Examensarbete. ISRN SLU-SRG-AR--31--SE.

33 Jonsson, Ö. Trädskikt och ståndortsförhållanden i strandskog. - En studie av tre bäckar i Västerbotten. Examensarbete. ISRN SLU-SRG-AR--33--SE.

35 Claesson, S. Thinning response functions for single trees of Common oak (Quercus Robur L.) Examensarbete. ISRN SLU-SEG-AR--35--SE.

36 Lindskog, M. New legal minimum ages for final felling. Consequences and forest owner attitudes in the county of Västerbotten. Examensarbete. ISRN SLU-SRG-AR--36--SE.

40 Persson, M. Skogsmarksindelningen i gröna och blå kartan - en utvärdering med hjälp av riksskogstaxeringens provytor. Examensarbete. ISRN SLU-SRG-AR--40--SE.

41 Eriksson, F. Markbaserade sensorer för insamling av skogliga data - en förstudie. Examensarbete. ISRN SLU-SRG-AR--41--SE.

45 Gessler, C. Impedimentens potientiella betydelse för biologisk mångfald. - En studie av myr- och bergimpediment i ett skogslandskap i Västerbotten. Examensarbete. ISRN SLU-SRG-AR--45--SE.

46 Gustafsson, K. Långsiktsplanering med geografiska hänsyn - en studie på Bräcke arbetsområde, SCA Forest and Timber. Examensarbete. ISRN SLU-SRG-AR--46--SE.

47 Holmgren, J. Estimating Wood Volume and Basal Area in Forest Compartments by Combining Satellite Image Data with Field Data. Examensarbete i ämnet Fjärranalys. 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. Examensarbete SCA. ISRN SLU-SRG-AR--49--SE.

1999 55 Imamovic, D. Simuleringsstudie av produktionskonsekvenser med olika miljömål. Examensarbete för Skogsstyrelsen. ISRN SLU-SRG-AR--55--SE

62 Fridh, L. Utbytesprognoser av rotstående skog. Examensarbete i skoglig planering. 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. Examensarbete i biometri. ISRN SLU-SRG-AR--71--SE.

72 Skoog, E. Leveransprecision och ledtid - två nyckeltal för styrning av virkesflödet. Examensarbete i skoglig planering. ISRN SLU-SRG-AR--72--SE.

74 Johansson, L. Rotröta i Sverige enligt Riksskogstaxeringen. Examens arbete i ämnet skogsindelning och skogsuppskattning. ISRN SLU-SRG-AR--74--SE.

77 Nordh, M. Modellstudie av potentialen för renbete anpassat till kommande slutavverkningar. Examensarbete på jägmästarprogrammet i ämnet skoglig planering. ISRN SLU-SRG-AR--77--SE.

78 Eriksson, D. Spatial Modeling of Nature Conservation Variables useful in Forestry Planning. Examensarbete. ISRN SLU-SRG-AR--74--SE.

81 Fredberg, K. Landskapsanalys med GIS och ett skogligt planeringssystem. Examensarbete på skogsvetarprogrammet i ämnet skogshushållning. ISRN SLU-SRG-AR--81--SE.

2001 83 Lindroos, O.Underlag för skogligt länsprogram Gotland. Examensarbete i ämnet skoglig planering. ISRN SLU-SRG-AR--83-SE.

84 Dahl, M. Satellitbildsbaserade skattningar av skogsområden med röjningsbehov. Examensarbete på akogsvetarprogrammet i ämnet skoglig planering. ISRN SLU-SRG-AR--84--SE.

85 Staland, J. Styrning av kundanpassade timmerflöden - Inverkan av traktbankens stlorlek och utbytesprognosens tillförlitlighet. Examensarbete i ämnet skoglig planering. ISRN SLU-SRG-AR--85--SE.

2002 92 Bodenhem, J. Tillämpning av olika fjärranalysmetoder för urvalsförfarandet av ungskogsbe stånd inom den enkla älgbetesinventeringen (ÄBIN). Examensarbete på skogsvetarprogram met i ämnet fjärranalys. ISRN SLU-SRG-AR--92--SE.

Internationellt: ***(International issues)***

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

44 Sandewall, M., Ohlsson, B., Sandewall, R.K., Vo Chi Chung, Tran Thi Binh & Pham Quoc Hung. People´s options on forest land use. Government plans and farmers intentions - a strategic dilemma. ISRN SLU-SRG-AR--44--SE.

48 Sengthong, B. Estimating Growing Stock and Allowable Cut in Lao PDR using Data from Land Use Maps and the National Forest Inventory (NFI). Master thesis. ISRN SLU-SRG-AR--48--SE.

1999 60 Inter-active and dynamic approaches on forest and land-use planning - proceedings from a training workshop in Vietnam and Lao PDR, April 12-30, 1999. Edited by Mats Sandewall ISRN SLU-SRG-AR--60--SE.

2000 80 Sawathvong. S. Forest Land Use Planning in Nam Pui National Biodiversity Conservation Area, Lao P.D.R. ISRN SLU-SRG-AR--80--SE.