Set aside areas in certified private forest estates in Southern Sweden – are the best stands chosen?

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Master Thesis no. 156
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ABSTRACT

The concept of sustainable forest management and biodiversity conservation has become more and more important in the last decades. The preservation of key habitats and ecologically valuable forests is recognized to be a goal in the planning process. Forest certification is a tool used to implement and achieve this objective. In Sweden the Forest Stewardship Council (FSC) certification imposes to the forest owners who want to be certified, to set aside at least 5% of their properties for biodiversity purposes. In southern Sweden this mechanism becomes very relevant, since the small private forest is the most common form of ownership.

This thesis aims to investigate how much the conservation value of the set aside areas differs among different estates. Furthermore the presence of structures important for biodiversity in such small private forest estates is analysed, in particular comparing set aside areas and the most ecologically valuable non set aside areas.

The question that was tried to be answered was if the stands presenting the highest ecological and biodiversity values were those set aside.

The study implementation consisted of inventorying ten estates certified according to FSC scheme and estimating the ecological value of the stands belonging to both, set aside and non set aside areas. A simplified biodiversity estimate was used where features representing the most important structures for forest biodiversity were checked. In particular different types of dead wood were surveyed and analysed, tree diameters (as a representation of old trees) and deciduous tree component. In addition an assessment of biodiversity potential was conducted in each stand, as a further variable which gives a score indicating the presence of valuable elements.

The data analysis showed that there was no significant difference in the amount of dead wood between set aside and non set aside stands. The only difference that was found was in the amount of lying dead trees, with a slightly higher volume for the non set aside area. The field survey, combined with the biodiversity potential and the data revealed that in some cases low productive stands were preferred to stands with higher ecological characteristics in the setting aside process. A lack of large trees was also noticed.

In conclusion, as a general observation, it could be said that in certified small private forest estates, a good management of stands presenting high biodiversity potential is conducted. Yet here are elements that could be improved, like ensuring the percentage of the forest set aside fully corresponds to the most ecologically valuable area. Furthermore, the

management could be done in a more efficient way, with more careful attention to substrates and element lacking in the landscape, such as large trees and deadwood.
Key words: set aside forest, biodiversity, ecological values, private forest owners

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1. INTRODUCTION

Sweden is a country where 56% of the territory is occupied by productive forest land (KSLA, 2009). The forestry sector is economically important, where the Swedish forestry model is built and mainly works efficiently because it is largely based on technology and mechanized operations and it is provided with a very good net of logistic infrastructures. In the last decades, the emerging nature concern has made the Swedish Forestry Agency (Skogsstyrelsen) revise its model, towards a deeper environmental management. The national forest policy currently in force, enacted by Parliament in 1993, incorporates the commitments made by Sweden at the United Nations Conference on Environment and Development (UNCED) at Rio de Janeiro in 1992. At the present, forest management aims to cater for both timber production and environmental purposes, in forest where the two goals carry equal weight. Consequently, to the existing national parks and nature reserves, other different protected areas have been instituted, as for instance habitat protected areas and natural monument (Skogsstyrelsen, 2007). Approximately 11% of Sweden's land is protected by some kind of nature conservation legislation, where about 5% of the productive forest land is site protected with the above mentioned legal instrument (Skogsstyrelsen, 2007). Besides these figures, the voluntarily set aside area by forest owners (estimated to be 4% of the productive forest land in Southern Sweden), should be added so the protected land considerably increases. Consequently the mechanism of voluntarily setting aside forest land becomes extremely relevant in southern Sweden, where 80% of the forest land is owned by non-industrial private forest owners (Ask, 2002).

1.1. Objectives of the thesis

The aim of this thesis was to assess, in small privately owned forest estates in Southern Sweden, the quantity of different elements representing ecological values in forest stands and their biodiversity potentials. Emphasis was mainly laid on structures of managed broadleaved forests and their ecological values in non-industrial private forests. Differences in set aside and non set aside areas were surveyed in order to assess if the best sites from a biodiversity point of view corresponded to the land preserved. The main researched questions were:

- Is there any difference in age of the different stands between set aside and non set aside areas?
- Is there any difference in the amount of dead wood?

- Is the assessment of biodiversity potential affirming that the stands with higher scores are those set aside?

For the implementation of these ideas, ten estates closely located and certified according to FSC scheme were inventoried; set aside and non set aside stands were surveyed and through data analysis compared in terms of different forms of dead wood, large trees, age and nature value assessment.

2. BACKGROUND

2.1. Sustainable forest management in Sweden

Nowadays the concept of sustainable forest management is largely used but it is difficult to contextualize it, since there is no universal definition and it can be applied to a broad range of forestry aspects. In Sweden, the first paragraph of the Forestry Act states that "The forest is a national resource that shall be managed in such a way that it gives sustainable and good yields at the same time as biological diversity is maintained". The sustainable forest management is defined as "The value of forests and forest land for biological production must be protected, at the same time as biological diversity and cultural heritage and recreational assets are safeguarded" (Skogsstyrelsen, 2005). Whereas sustainability is among the forest management objectives, one of the major goals should be restoration and preservation of a high biodiversity (Nilsson *et al.*, 2001; Drakenberg and Lindhe, 2001). In other words, the maintenance of biological diversity is a fundamental aspect of sustainable forest management.

2.2. How is biodiversity preserved in managed forests?

Actions voluntarily taken require that forest owners provide a report of the environmental and cultural values in their forests. Alternatively, the forest owner can make a forest management plan which includes this information. The purpose is to encourage landowners to recognise the ecological values of their forests, thus enabling them to take these values into account (Fromond *et al.*, 2009).

The National Board of Forestry has developed a policy to protect endangered species by slightly modified forest management and by preserving small areas characterised by the occurrence or possible occurrence of threatened species (Hansson, 2001), the so called key habitats, which now cover 0.8% (ca 200,000 ha) of the productive forest land. The protection and management of key habitat sites is, to a large extent, left to the owner, therefore key habitats are not protected by law, but through forest certification schemes.

Within this framework, it is clear that the mentality of seeing forest as a mere source of timber is overtaken, and other functions and values have arisen.

There have been relevant studies and efforts during the last 15 years, trying to identify and map sites valuable from a biodiversity point of view. Examples are the National Survey of Key Habitats and the common use of forest certification system, which ensures the protection of sites of interest. The certification process has become globally well established

(Rametsteiner and Simula, 2003), and there are two major certification schemes used worldwide, which to a great extent are very similar, namely Pan European Forest Certification (PEFC) and Forest Stewardship Council (FSC). In this work the latter is considered. Making it clear first that the certification process is a voluntary action, once the forest owner has decide to become certified, the areas to set aside cannot be freely chosen. The Swedish FSC Standard for Forest Certification (FSC, 1998) states that areas of highest biodiversity value should be given higher priority when areas are set aside for biodiversity significances and that a minimum of 5% of the forest land should be set aside (full text in appendix 1):

6.1.2 At least 5% of the productive forest area is exempted from measures other than the management required to preserve and support the natural biological diversity of the habitat. Selection and demarcation areas shall be prioritized according to their importance for biodiversity and representativity in the landscape.

Another tool used for protecting areas with ecological values is the "Green Forest Management Plan", which is also relevant concerning forest certification for family-run businesses. It contains details regarding stands production and environmental values and it should be a basis for decision making (Skogsstyrelsen, 2005). Within the planning phase of classifying the forest stands, four different goal classes are used to describe the long-term direction, elaborated by the Swedish Forest Agency:

- PG - production goals with general environmental considerations
- PF - production goals with reinforced considerations
- NS - environmental goals with adapted management
- NO - environmental goals with undisturbed forest

Information for classifying the stands into the above classes and for deciding which have higher priority in the setting aside process, is generally obtained through an assessment of biodiversity and ecological values which is carried out before the certification and planning processes.

2.3. Inventory for ecological and biodiversity values

Biodiversity can be assessed in various ways, such as identifying and counting all species, but this method is time and cost demanding and highly specialised knowledge is needed, therefore it is almost never done. A more feasible way can be done according to two different principles, where one is to use structures known to be important for a large number of species (e.g. Nilsson *et al*., 2001; Lindhe and Drakenberg, 1996; 2000; Skogsbiologerna, 2004). Another could be to inventory species or groups of species known to indicate a high biodiversity or presence of many red-listed species (Nilsson *et al*., 1995). The present work consists of estimating the ecological value of forest stands, using forest features or structures known to be important for a large number of species, namely dead wood, old large trees and share of broadleaves. These last factors represent the three most important structures for forest biodiversity according to a broad number of studies (Nilsson *et al*., 2001; Hansson, 2001; Ohlson *et al.*, 1997; Harmon *et al.*, 1986; Kangas and Pukkala, 1996; Fridmand and Walheim, 2000) and are considered in this work.

2.3.1. Forest features important for biodiversity

In Sweden approximately 50% of the red-listed species are dependant on forest, mainly due to the scarcity of old living trees (especially broadleaves), logs and snags (Berg *et al.*, 1994). Consequently there are several variables and aspects that can be used as ecological indicators, thus estimates of biodiversity.

In this study the stand structure was looked at focusing on tree age and investigating mainly broadleaves formation. Firstly because in all types of forests many species are dependent on old trees (especially epiphytic lichens and wood beetles), called ancient trees, secondly because oak and beech are the most important trees for endangered species dependent on hollow trees in northern Europe (Nilsson *et al.*, 2001).

Deadwood was another component investigated, as according to Jonsell *et al.* (1998)

Figure 2-1 Forest presenting indicators of biodiversity: high stump, standing dead trees, dead wood and fungi decay. (Photo Giulia Attocchi)

it is a fundamental substrate for several endangered species. Ohlson *et al*. (1997), who studied biodiversity within natural old-growth swamp forests in Sweden, proved that the amount of dead wood present was the most important variable explaining biodiversity, i.e. the higher amount of dead wood the greater the biodiversity. Dead wood is a fundamental structural component (Harmon *et al.*, 1986), which was previously abundant at a landscape level but now is generally scarce (Linder and Ostlund, 1992). It was also investigated by Berg *et al*., (1994) that in Sweden 80% of the red-listed forest insects are dependent on specific habitat elements, mainly old trees, down logs and standing dead trees.

There are studies that discuss the environmental effectiveness of set aside areas (Schlyter *et al*., 2009; Ask, 2002). Andersson (2002) investigating several management plans developed during the certification process, concluded that in reality the areas with the highest biodiversity values on an estate, are not always those set aside. It was also concluded by Ask (2002) that the process of setting aside area within non-industrial private forest ownership could be done in a more efficient way.

3. MATERIAL AND METHODS

3.1. Study area description

The estates investigated for the purpose of this thesis are located in the southern part of Sweden, between Skåne and Halland regions (Figure 3-1).

Figure 3-1 Location of the study area in Southern Sweden

Southern Sweden is characterised by a fairly flat morphology, ranging from 0 to 350 m a.s.l.; it is surrounded by water on the west, south and east coasts by the Öresund Strait and the Baltic Sea respectively. The region has a maritime climate, with a mean annual temperature between 5° and 8° C (Vedin, 1995); annual precipitation ranges from approximately 500 mm in the east to 1200 mm in the west (Alexandersson and Andersson, 1995).

The dominating forest type in the nemoral zone should be constituted by deciduous hardwood tree species; however spruce plantations are abundant in the whole area (Diekmann, 1999) and the former hardwood dominated landscape rich in tree species has been replaced by uniform coniferous forests primarily dominated by Norway spruce (*Picea abies* Karst) (Björse and Bradshaw, 1998).

3.2. Location and selection of estates and stands

The estates were chosen according to the following criteria: to be located in Southern Sweden, to have a forest management plan, to be certified according to FSC scheme and with a tree species composition well represented by broadleaves. Those criteria were based upon the fact that the most common forest ownership in southern Sweden is small private forest owners (Ask, 2002) and in practical forest management, the preservation of biodiversity is done

through the management plan. The attention was focused on broadleaves because this region is considered part of the nemoral and boreo-nemoral zone, where broadleaved tree species would have probably constituted a large proportion of the forests if the forests had been left unmanaged (Bjorse and Bradshaw, 1998). A description of the main features of each estate is reported in Table 3-1. All information was provided by Sydved, a Swedish forest company that operates in Southern Sweden, whose main activities are buying timber and providing forest service along with advices in forest management.

Table 3-1 Description of the main characteristics of the estates under study. Last column indicated as "Area surveyed" shows the sum of the area of the stands surveyed in the corresponding estate

Estate	**County**	**Municipality**	**Total area**	**Area set aside**		**Area surveyed**
				(ha)	**%**	**(ha)**
a	Halland	Laholm	34.7	2.3	7.0	3.9
b	Skåne	Kristianstad	74.0	4.8	6.0	9.7
c	Skåne	Ängelholm	25.8	1.7	7.0	6.4
d	Skåne	Hässleholm	73.0	5.7	8.0	12.7
e	Skåne	Klippan	32.0	5.2	16.0	7.8
f	Skåne	Åstorp	89.3	13.9	15.6	19.0
g	Skåne	Ängelholm	30.3	3.2	11.0	4.6
h	Skåne	Örkelljunga	27.1	1.5	6.0	5.7
i	Skåne	Kristianstad	91.2	8.1	9.0	3.7
j	Skåne	Hässleholm	68.5	4.2	6.1	8.9
Total			545.9	50.6	9.3	81.9

Within each estate, two sets of stands were surveyed: the set aside and the best non set aside from biodiversity point of view. The latter was chosen looking at tree species composition, age and qualitative subjective estimation, along with information provided by the forest management plan. Ten private forest estates were included in the study; four stands in each estate were inventoried, two per each category mentioned above, resulting in 40 stands. In total 81.9 ha of forest were assessed, 28.3 ha set aside and 53.6 ha non set aside.

3.3. Field work inventory

The field work was carried out in February and March 2010. In each stand, three surveys were conducted: an objective and a subjective inventory and the assessment of biodiversity potential.

3.3.1. Objective and subjective inventories

In each selected stand, circular sample plots of 100 m^2 were made, in a number proportional to the area of the stand (Table 3-2). In the objective inventory they were located along the longest axis of the stand, at a distance equal to the length of the axis divided by the number of samples.

The subjective plots were chosen in order to catch valuable sites, otherwise omitted with only an objective inventory.

Table 3-2 Number of plots per estate

Area (ha)	No. of plots
0-1	6
1.1-2	8
>2.1	10

In each sample, features retained to be important for biodiversity were recorded: deadwood (in different forms, see below), coarse trees (DBH >60 cm) and natural values of singular trees or sites.

Deadwood

Listed below there is the description of how the different components of deadwood were considered and what was measured in the field inventory. The minimum diameter was set at 10 cm.

- Standing dead trees: species, DBH , height, crown status (percentage left);
- Lying dead trees: species, DBH and length, crown status (percentage left);
- Part of standing trees, stumps (>10 cm): species (if possible), mid diameter, length;
- Part of lying dead trees (>10 cm): species (if possible), top and bottom diameter, length.

Large trees

Large trees were inventoried through recording the frequency, the diameter at breast height (DBH), setting a minimum of 60 cm and taking notes of particular characteristics that could stand out as natural values of trees, like nesting holes, damages and branching.

3.3.2. Assessment of biodiversity potential

In conjunction with the above inventory, a method called "assessment of biodiversity potential" or "nature value assessment" (Lindhe and Drakenberg, 1996; 2000) was used for each stand. The assessment consists of three steps in terms of 1) selecting the stands to be assessed, 2) assessing the homogeneity of the individual stand, and 3) filling in the data sheet (Appendix 2) and counting the points. As it can be seen from the data sheet, a structure or site characteristic that gives a high score could represent a broad range of characteristics (particular tree species, lichens, fungi, fire, large trees, dead wood, topography). The points cannot be used as an absolute gauge, on the contrary they must be valued. This is partly because many of the issues are determined by a degree of subjectivity (significantly, eye-catching), and furthermore the system does not prioritize what is locally rare / unique. Consequently the final score has to be adjusted with other characteristics and evaluation that could lift an item up in the classification. Along with the assessment comes a guideline with suggestions of how classify those stands and interpret the score (Appendix 4).

3.4. Data elaboration

The formulas used for the calculation of the dead wood volumes are reported in Appendix 3. For the elaboration and analysis of the data, the programs Microsoft Excel and the statistics software SPSS 14.0 were used.

For the comparison between the two categories of stands, namely set aside and non set aside, the unpaired student's t-test was used. In order to test the difference inter and intra stands and estates the two way analysis of variance ANOVA test was conducted.

4. RESULTS

4.1. Age

All the stands were even aged, therefore only one value is shown for each stand (Table 4-1). Both the non set aside stands were older than the set aside stands in three estates, while the reverse happened just once. In the six remaining estates, the oldest stands were present both in set aside and non set aside areas.

Table 4-1 Age distribution of the stands surveyed in each estate, ranked in descending age order; values with an asterisk indicate when both non set aside are older than set aside stands

Estate	**Set aside**				**Non set aside**				**Set aside**	**Non set aside**
	Age	**Rank**	**Age**	**Rank**	**Age**	**Rank**	**Age**	**Rank**		
a	66	1	86	2	126	4	113	3	3	7*
b	123	4	43	1	78	2	113	3	5	5
c	52	3	122	4	47	2	42	1	7*	3
d	30	1	85	3	105	4	70	2	4	6
e	71	1.5	71	1.5	121	4	111	3	3	7*
f	124	2.5	69	1	124	2.5	124	4	3.5	6.5
g	76	2	66	1	81	3.5	81	3.5	3	7*
h	26	1	96	3.5	96	3.5	91	2	4.5	5.5
i	121	4	66	2.5	66	2.5	51	1	6.5	3.5
j	105	2	110	3	120	4	80	1	5	5

4.2. Dead wood

4.2.1. Objective inventory

On average in all stands there were 9.56 m^3/ha of dead wood, 8.43 m^3/ha in the set aside area and 10.68 m^3/ha in the not set aside.

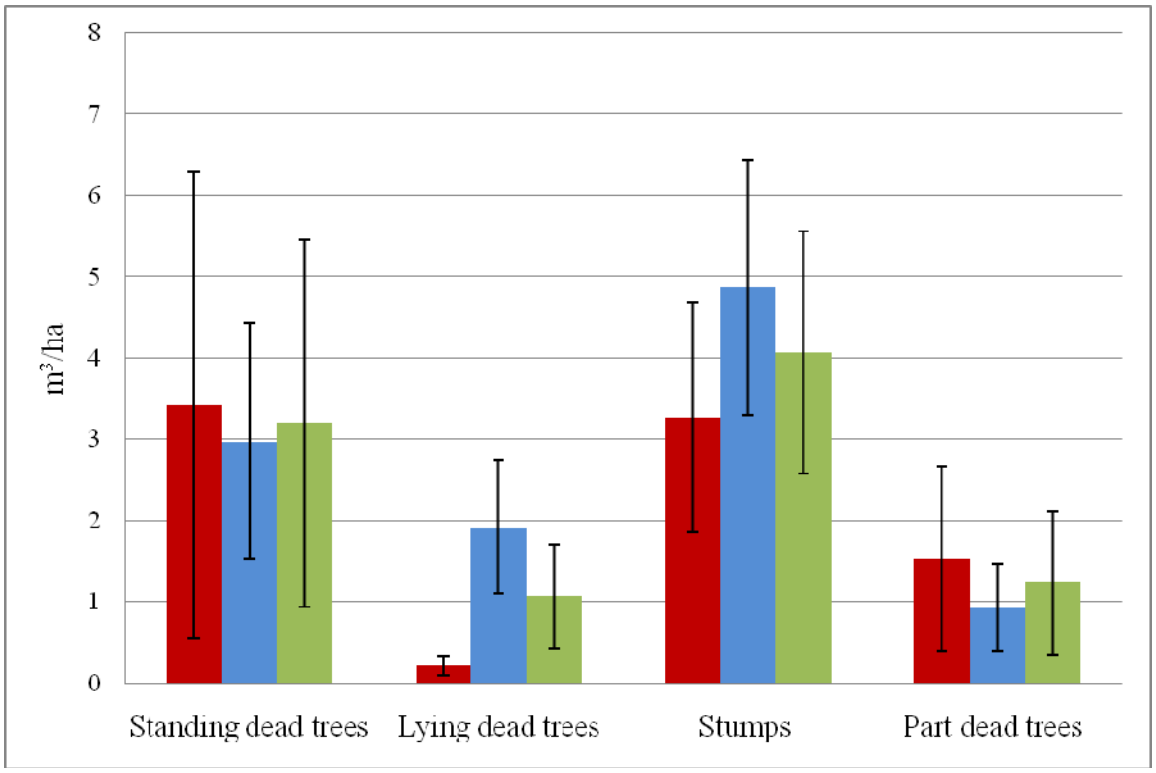

Figure 4-1 Mean values of the amount of standing dead trees, lying dead trees, stumps and part of dead trees in set aside (red bars) and not set aside (blue bars) and total (green bars) stands. The error bars represent the 95% confidence interval

The unpaired student's t-test showed that the amount of dead wood, standing dead trees, high stumps and part of dead trees was not significantly different in set aside and not set aside areas if all the estates are clumped together. However considering only the volume of lying dead trees, there was a difference with higher volume in the non set aside areas. The reference t-value tabulated with n=40 and p=0.05 is 2.02 (38).

There was a large difference in the levels of dead wood between the estates and also between the stands, ranging between a minimum of 0.04 m^3/ha to a maximum of 40.64 m^3/ha (Fig 4-2).

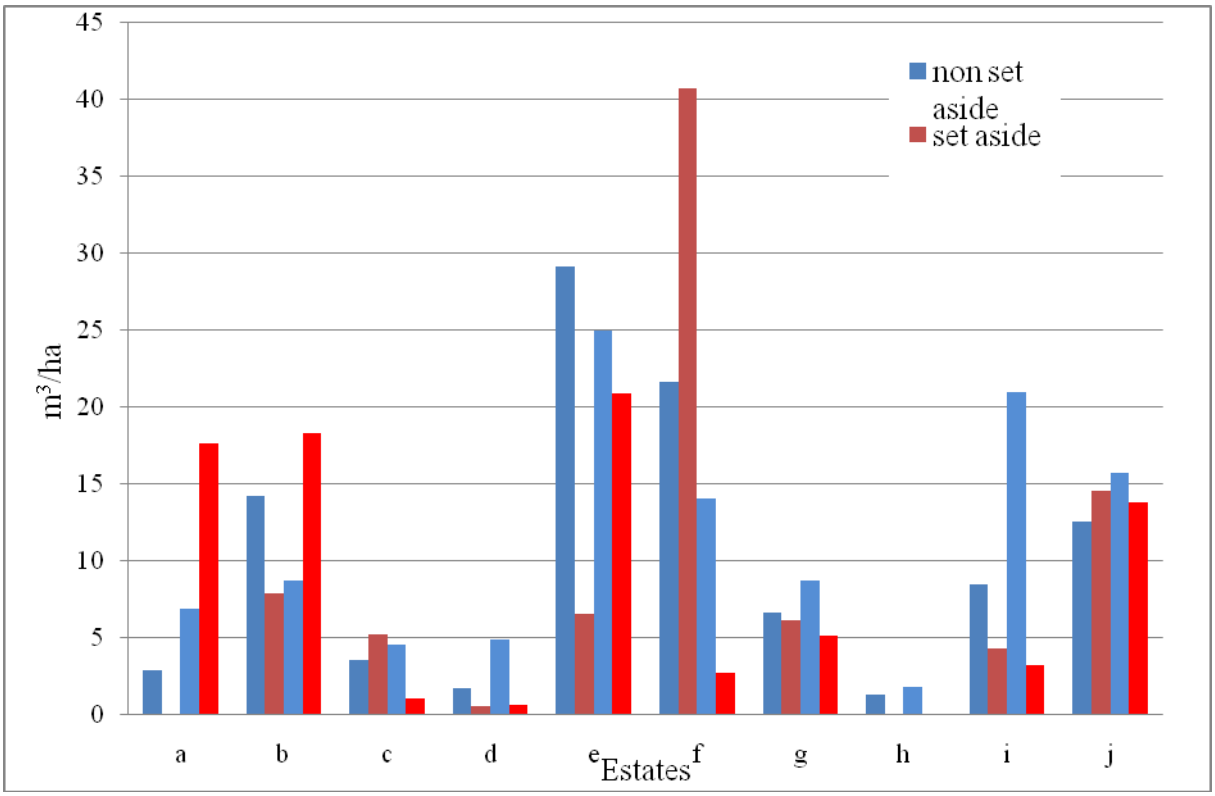

Figure 4-2 Amount of dead wood (m^3/ha) present in all the stands surveyed (objective inventory)

This was confirmed be the two way analysis of variance which showed that there are differences among estates and stands ($p<0.05$); but not between set aside and non set aside.

The same test was conducted for all the different components of dead wood, namely dead standing trees, lying dead trees, stumps and parts of lying dead trees. The only significant difference was recorded among estates and stands for stumps ($p<0.05$) and between set aside and non set aside areas for lying dead trees (Table 4-2). In all the other cases, there was no significant difference between set aside and non set aside areas.

Table 4-2 Results of the analysis of variance for snags, lying dead trees, stumps, part of lying dead trees and total dead wood; starred values in the last column to emphasise the significant differences

	Total	**Set aside**	**Non set aside**		**df**	**F**	**p-value**
Snags	3.20	3.42	2.97	Estates	9	1.470	0.226
				Stands	19	0.858	0.629
				Set aside/non set aside	1	0.041	0.842
Lying dead trees	1.07	0.21	1.92	Estates	9	1.204	0.346
				Stands	19	1.701	0.123
				Set aside/non set aside	1	9.551	0.006*
Stumps	4.07	3.27	4.86	Estates	9	5.569	0.001*
				Stands	19	3.675	0.003*
				Set aside/non set aside	1	2.682	0.117
Part dead tree	1.23	1.53	0.93	Estates	9	4.496	0.002*
				Stands	19	2.436	0.027
				Set aside/non set aside	1	0.593	0.450
Total	10.68	8.43	10.68	Estates	9	3.245	0.014*
				Stands	19	3.120	0.008*
				Set aside/non set aside	1	0.850	0.368

4.2.2. Subjective inventory

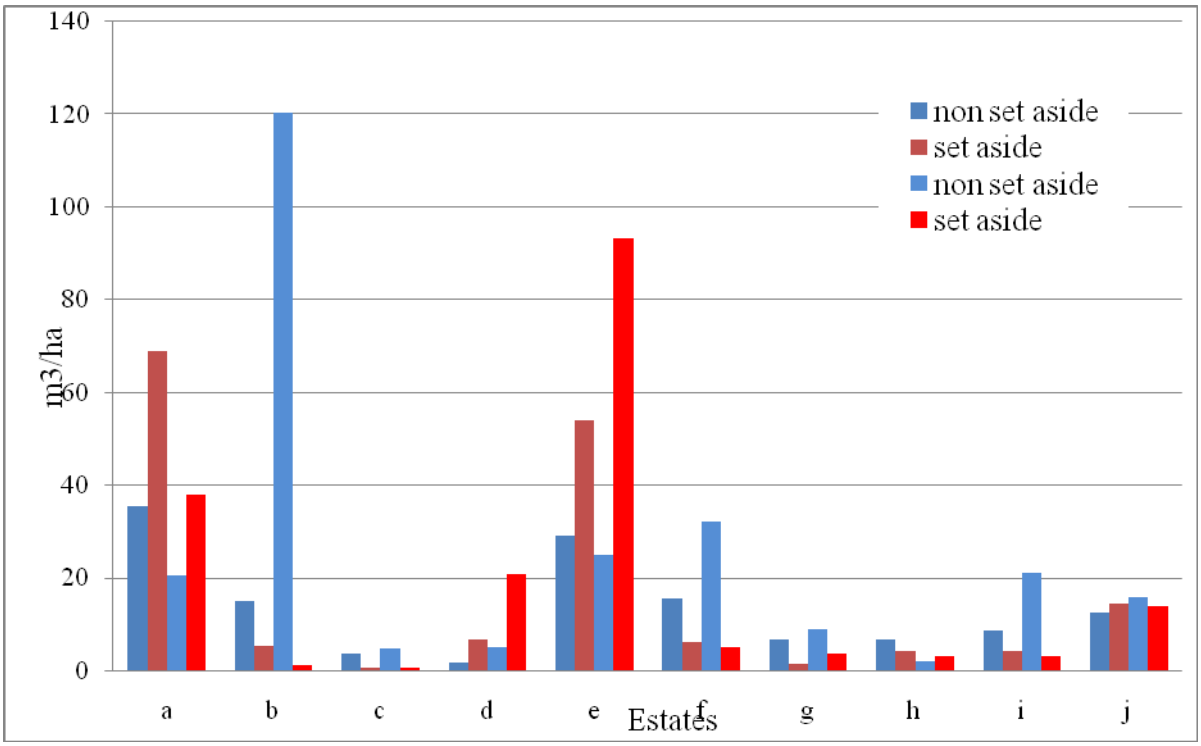

Figure 4-3 Amount of dead wood (m^3/ha) present in all the stands surveyed (subjective inventory)

The highest volume in the subjective inventory (120.4 m^3/ha) was by far bigger than that in the objective inventory. Taking into account the different nature of the two inventories, it is not possible to compare subjective and objective data from a statistical point of view. Still some observation could be made. For instance the differences in estates b, e and f in the two different inventories.

4.3. Coarse trees

In all plots trees with diameter larger than 60 cm were recorded and the average diameter of those trees and frequencies were calculated. From the objective inventory coarse trees were present in 3 out of a total of 40 stands, where the largest diameter recorded was a beech (*Fagus sylvatica* L.) of 80 cm DBH in a set aside stand. There was no significant difference between set aside and non set aside ($p>0.05$).

From the subjective inventory, it resulted that in 7 out of 40 stands coarse trees were present, where the frequency was higher in set aside area, comprehending also the largest tree (beech,

75 cm DBH); however there was no significant difference between set aside and non set aside.

4.4. Assessment of biodiversity potential

Table 4-3 Final score of the "assessment of biodiversity potential" for each stand considered

Stand	**Score of biodiversity potential**									
	set aside				**non set aside**				**Set aside**	**Non set aside**
	Score	**Rank**	**Score**	**Rank**	**Score**	**Rank**	**Score**	**Rank**		
a	8.0	3	14.0	4	6.5	1	7.0	2	7*	3
b	6.0	1	13.0	3.5	9.0	2	13.0	3.5	4.5	5.5
c	6.0	1	7.5	4	6.5	2	7.0	3	5	5
d	15.5	4	11.5	2	13.5	3	8.0	1	6	4
e	9.0	1	11.0	2	14.5	3	15.5	4	3	7*
f	12.5	2	13.0	3	16.0	4	11.5	1	5	5
g	12.0	3	6.0	1	13.0	4	7.0	2	4	6
h	7.0	1	15.0	4	8.0	2	8.5	3	5	5
i	7.0	2	9.0	3	5.0	1	10.0	4	5	5
j	13.0	3	12.0	2	9.0	1	13.5	4	5	5

All stands within the same estate were ranked from 1 to 4 (according to descending biodiversity potential score) and then this rank was summed up separately for set aside and non set aside (Table 4-3). In three estates out of ten, the non set aside stands had a higher biodiversity potential score, where in one case both non set-aside stands had a better one. The contrary, i.e. set aside stands had higher score in biodiversity potential, was found in two cases, one estate had both stands with the highest scores. In the remaining five estates, the scores broke even between set aside and non set aside. According to the guidelines of the interpretaion of the biodiversity potential (Appendix 4), the minimum score to have a reasonable good stand is nine points. However it has to be born in mind that this assessment should be used complementary to other parameters, and not used as the main discriminant factor.

Looking at the percetage of area that is covered by certain range of points, it can be noticed that the set aside part has more area with a higher score (Figure 4-4), but still the non set aside parts has more area in the last two highest classes (≤15 and >15).

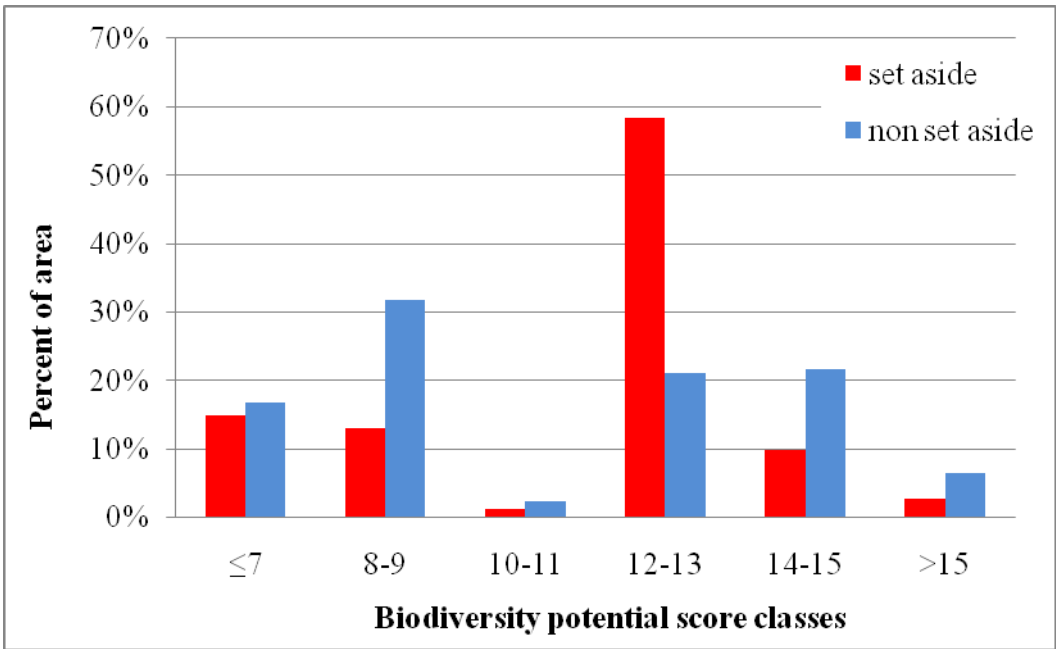

Figure 4-4 The percentage of area belonging to different "score classes" in the estates as a proportion of the all area surveyed, set aside and non set aside

Of the total set aside area, more than 70% has a high biodiversity potential score (≥11) if compared with the other stands, while non set aside has approximately 55% of its area with nine or less points, meaning that they had lower biodiversity scores than other stands.

It could be concluded that the non set aside part had more small sites with high scores since it presented the highest points in absolute terms but less area in the last three score classes. The contrary happened for the set aside part, thus bigger stands with a rather good score, but not as good as the non set aside part.

4.5. Intra estate comparison

In this paragraph there is a brief description for each estate and stand surveyed. The scheme below (Table 4-4) shows the differences among stands, emphasising the field survey results and a more descriptive and personal evaluation is reported in Appendix 6. The rank order indicates the best stands (here meant after having considered the entire inventory and the field survey evaluation) and in the last column there is a straightforward comment indicating the reason why they were chosen and given the corresponding rank.
All estates had accomplished the minimum level of 5% of set aside land.

Table 4-4 Main features of the estates, intra estate comparison and personal evaluation, based on field inventory, survey and biodiversity assessment. (Stand: set aside (sa) and Non set aside (nsa). Tree species composition: Pine (P), Norway spruce (S), birch (Bi), beech (Be), other broadleaves (O) and other noble broadleaves (OB))

Estate	**Stand**	**Age**	**Tree species composition**						**Dead wood (m^3)**	**Biodiv. score**	**Rank**	**Comment**
			P	S	Bi	Be	O	OB				
a	sa	66	10	10	70	10	0	0	0.0	8.0	2	hazel coppice
	sa	86	20	0	40	30	0	10	17.6	14.0	1	very good
	nsa	126	90	1	9	0	0	0	2.9	6.5	3	classic productive forest
	nsa	113	70	0	30	0	0	0	6.9	7.0	4	classic productive forest
b	sa	123	0	0	0	30	70	0	7.8	6.0	3	swampy area
	sa	43	0	0	20	0	0	80	18.3	13.0	2	very good
	nsa	78	2	3	85	4	1	5	14.3	9.0	4	standard forest
	nsa	113	0	0	5	0	90	5	8.8	13.0	1	very good
c	sa	52	5	5	90	0	0	0	5.2	6.0	2	good
	sa	122	0	0	0	95	5	0	1.1	7.5	1	very good
	nsa	47	5	5	90	0	0	0	3.6	6.5	4	wet area
	nsa	42	0	0	50	0	0	50	4.6	7.0	3	good but young
d	sa	30	0	30	0	0	0	70	0.5	11.5	4	young
	sa	85	0	0	10	50	40	0	0.7	15.5	2	very good
	nsa	105	0	0	0	80	20	0	1.7	13.5	1	very good
	nsa	70	10	0	10	0	70	10	4.9	8.0	3	good
e	sa	71	80	1	19	0	0	0	6.5	9.0	4	wet, low natural value
	sa	71	0	0	10	0	0	90	20.8	11.0	3	wet, low natural value
	nsa	121	0	0	2	95	2	1	29.1	14.5	2	standard productive forest
	nsa	111	1	4	15	5	70	5	24.9	15.5	1	very good
f	sa	124	0	0	15	40	40	5	40.6	12.5	2	good stand
	sa	69	0	10	90	0	0	0	2.7	13.0	3	low natural value
	nsa	124	0	0	0	99	1	0	21.6	16.0	1	high values. very good
	nsa	124	0	0	0	100	0	0	14.1	11.5	4	standard productive forest
g	sa	76	0	0	15	5	0	80	6.1	12.0	2	good stand
	sa	66	30	20	50	0	0	0	5.1	6.0	4	too young. low nature value
	nsa	81	0	0	0	100	0	0	6.7	13.0	1	good stand
	nsa	81	0	100	0	0	0	0	8.8	7.0	3	low nature vale
h	sa	26	0	0	10	0	0	90	0.0	7.0	4	too young. low nature value
	sa	96	0	0	0	99	0	1	0.0	15.0	1	very good. high value
	nsa	96	0	0	0	100	0	0	1.3	8.0	3	standard productive forest
	nsa	91	65	0	0	30	5	0	1.8	8.5	2	good stand
i	sa	121	0	0	5	5	90	0	4.3	7.0	1	rather good stand
	sa	66	0	0	0	0	0	100	3.2	9.0	3	little species diversity
	nsa	66	0	0	30	0	0	70	8.5	5.0	4	low values

	nsa	51	0	0	40	0	0	60	20.9	10.0	2	high values, young. future potential
j	sa	105	0	0	0	70	30	0	14.5	13.0	1	good stand
	sa	110	0	0	0	80	20	0	13.8	12.0	3	rather good stand
	nsa	120	0	0	0	70	30	0	12.6	9.0	4	rather good stand
	nsa	80	0	0	0	100	0	0	15.7	13.5	2	good stand, little tree species variation

5. DISCUSSION

5.1. Age

The results presented in this study show that of the stands surveyed, the majority of non set aside stands were older than those set aside. In fact, in three estates, two stands out of two were considerably older than set aside ones, while the contrary occurred once. Considering that according to the FSC guidelines (paragraph 6.1 in appendix 1) priority in preservation of land should be given, among other things, to old trees, it seems that the best stands were not chosen in all the cases. The choice of certain stands rather than others was not random in this study, but based on the management plans, as described formerly. The decision was not based just on age factor; therefore there are other characteristics that have influenced such choices.

5.2. Deadwood

The total amount of dead wood does not differ between set aside and non set aside areas. However, the comparisons must be treated with caution as the inventory was conducted in rather small proportion of the whole estates, and errors could also be due to the inventorying method utilised. There were on average 9.56 m^3/ha of dead wood, where a slightly higher volume was counted for non set aside stands, yet no significant difference. This result is in accordance with the findings from the National Forest Inventory (Fridmand and Walheim 2000), which found 9.7 m^3/ha of dead wood in the boreo-nemoral zone of Sweden. In the more detailed analysis, just lying dead wood was a variable showing up statistically different, with higher volumes in the non set aside stands. This could be due to past forest operations, which could have left some residues in the forest, and hence increased the amount of down logs in managed stands. It has also to be said that when dead wood is compared with different studies it has to be done carefully, since the classification and nomenclature of dead wood and its components are not standardized, as also stressed by Fridmand and Walheim (2000). However, the levels of dead wood found in this and other studies (Fridmand and Walheim, 2000; Ohlson *et al.*, 1997; Nilsson *et al.*, 2001) are very low compared to natural forests. From the results of this work it appeared that the stands-chosen to be set aside because of their presumed high biodiversity do not have a larger amount of wood than a standard productive forest of southern Sweden. Similarly in central Sweden it was detected that the amount of dead timber in coniferous forests has decreased by more than 90% from the 1870s to the 1960s (Linder and Östlund, 1992). Some of the reasons why they have such low levels could

be due to the highly mechanized forestry operations and modern forestry practice (Jonsell *et al.*, 1998), the utilization of forest residues for bio fuel and the fact that certification started just approximately ten years ago, thus it has not had time yet to create and establish certain structures. Furthermore the nature of tree species composition could lead to less dead wood volumes, since broadleaves are more resistant to wind fall and in some cases the lifespan for those species is longer. Anyhow the consequences that the scarcity of deadwood might have for species and conservation are still uncertain. The decreased amount of deadwood in Scandinavian forest represents a threat for many species and the lack of appropriate substrate, like dead wood in this case, could act as a limiting factor especially for monophagous species (Jonsell *et al.*, 1998) and lead eventually to their extinction in certain areas.

5.3. Coarse trees

Even if few stands were checked, a scarce presence of large trees (>60 cm) was detected, and as general observation, there are few large trees. In addition, it was found that there was no significant difference in coarse trees between set aside and non set aside areas. One of the reasons could be that in the Swedish forestry system, relative short rotation ages are adopted, where trees are final felled long before their potential life span. Also, diameters asked by forest industries have a relatively small target, especially for coniferous species. The paragraph 6.5.5 of the FSC certification scheme, states clearly that large trees should be protected, for instance “trees that differ from the rest of the stand, particularly large, old trees” (full text in Appendix 1).

5.4. Evaluation of the method

Establishing whether or not an area is more ecologically valuable than another, or presents a higher biodiversity level is difficult and ambitious to determinate, where it is often almost impossible to give an unambiguous answer. Different methods and tools for nature value assessment have been investigated and used in the past (Böhl and Brändli, 2007; Drakenberg and Lindhe, 2001; Nilsson *et al.*, 2001). In certain cases, the best option is to combine various tools. In this thesis it has been chosen to investigate structures rather than species, along with elements that are ecologically significant. This simplification could lead to wrong conclusions. However, an underlying assumption is that species occur primarily in habitats or structures that contain certain visible features possible to assess. Different methodologies were combined together, forest inventories and assessment of biodiversity potential. It can be

argued about the types of forest inventory used, namely objective and subjective. The first was carried out in order to get reliable data of the estates, which could be processed and analysed. The subjective inventory was primarily done not to miss some valuable sites. It can be argued that the figures obtained from this second part of the survey are biased and not realistic, but it was meant to be an additional yet relevant aspect of the different stand to be discussed besides the mere objective data. The assessment of biodiversity potential is a tool used, generally speaking, as complement to traditional species inventories and here as further indicator for a better ecological site. Moreover as the inventory was not conducted in the whole area but parts of the estates were investigated, thus it could be possible that some other valuable sites were left out of this inventory. Anyhow it was attempted to minimize this factor with a careful analysis of the management plans and considerations during the field work. In fact the stands used for the inventory were selected before the field work. Different criteria were used as guidelines for the selection, which firstly was based on tree species composition, giving priority to noble and other broadleaved tree species. Secondly the oldest stands were chosen rather than younger stands. A further element came from the location of the stand within the estate: stands located in particularly sensitive spots (like close to rivers, open field or ecotone zones) were given priority when previous characteristics were equal.

6. CONCLUSIONS

There was no significant difference in the total amount of dead wood between set aside and non set aside stands of the estates. However, some differences were detected for high stumps and lying dead wood. Large trees were found to be very scarce all over the area analysed, even though some trees were recorded, mainly in set aside stands, but with no significant difference from non set aside. A possible reason highlighted could be the short rotation period adopted in Swedish forestry, along with the fact that the certification process started approximately ten years ago, thus there has not been yet the time to develop old-growth structures, even though old forest should have priority. Thus one of the main tasks of certification now is to create the bases, like setting aside now area with old or large trees, which eventually will develop into old-growth forests. The biodiversity assessment revealed a fair equity of points between set aside and non set aside areas, with a slight preference for non set aside stands. The majority of the stands had nine or more points, which is the threshold between high and low ecological values. Regarding the tree species composition, broadleaves were deliberately chosen, therefore they were the dominant species considered in this work.

It could be said that there is a number of reasons behind the choice to set aside a stand instead of another, where economic revenues probably are important. Even when the results do not show any difference, the field survey showed some other characteristics making a stand better than another. The personal feeling that I had during the field survey was that some valuable part were included in the set aside areas, but not all potential stands were used. In fact, the 5% imposed by certification was partly accomplished with forest land with high ecological value and biodiversity potential, but filled up with low productive forest land, wetlands and swampy sites. This is in accordance to what was observed by Andersson (2002), who identified an inclination to set aside wetlands rather than productive forest. Also Ask (2002) found that the mechanism for setting aside is done in a rather good way, but could be done more efficiently, like ensuring that all the ecologically valuable stands are exempt from measures other than the management required to preserve and support the natural biological diversity of the habitat and that efforts for creating substrates and structures important for a large number of species, especially endangered species, are enacted. Altogether, it seems that rather good choice was made in most cases, but there are some aspects and actions that should be revised, like the fact that not all the areas with high ecological values are set aside.

As a final remark, it is almost always necessary to make compromises between nature conservation and timber production. Therefore even with good intentions there will always be restrictions or conflicts in forest management, and therefore planning is essential for having a sustainable management and equal distribution of scarce resources. However, the open questions why those stands were set aside still remains, along with the doubts that sometimes economic reasons could have a great influence in the personal decision of the forest owners.

In general it can be said that in most cases correct stands have been chosen, but in other cases not. The most obvious “mistakes” regard the fact that stands with old trees have not been chosen, in spite of the clear statement in the FSC standard regarding the importance of certain forest elements and structures.

This study can be seen as a niche study, meaning that the biodiversity potential was measured in a limited and defined part of the forest land, without considering the landscape as a whole, where a continuous monitoring and further research is essential. By knowing more about the reality of the mechanism of voluntarily setting aside productive forest land, the forest managers will have a greater understanding about it and thus greater possibilities to improve and enlarge the efficiency of the method.

In conclusion there seems to be a basis for future development of preserving biodiversity, but still more could be done in the protection and creation of habitats important for numerous species.

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APPENDIX 1 Paragraph 6 of “The Swedish FSC Standard for Forest Certification”

6. Environment and biodiversity standard

6.1 The preservation and restoration of habitats.

The habitat described below shall be preserved and restored in order to give especially demanding species the opportunity to survive, and to serve as sources of dispersal and reference areas in the managed forest landscape.

6.1.1 The areas listed below are exempt from measures other than the management required to preserve and support the natural biological diversity of the habitat. Measures to promote outdoor activities may be taken on condition that the biodiversity values are not harmed.

a) Pronounced uneven-aged, multilayered natural forests with a great abundance of old trees and large dead wood in different stages of degradation.

b) Key habitats according to the definition and methodology of the National Board of Forestry.

c) Waste and other non-productive forest land (production less than 1 forest cubic metre per hectare and year).

6.1.2 At least 5% of the productive forest area is exempted from measures other than the management required to preserve and support the natural biological diversity of the habitat. Selection and demarcation areas shall be prioritized according to their importance for biodiversity and representativity in the landscape. (Exemptions may be made for landholdings of less than 20 hectares of productive forest land which have no areas that have, or may in the near future develop, high biodiversity values.) Measures to promote outdoor activities may be taken on condition that the biodiversity values are not harmed.

The following areas may be included here:

-created/restored forest wetland;

-areas according to section 6.1.1 a and b;

-shares in collectively owned nature conservation forest areas;

-other land with stands of trees that do not meet the conditions for environmental support, but where there is a sufficient grazing or haymaking to provide good conditions in which flora/fauna that are dependent on cultivation may thrive;

-areas for which nature conservation agreement have been signed with the County Forestry Board;

-where applicable, the part of a private landholding designated as a nature reserve or habitat protection area after deductions corresponding to the proportion for which compensation have been made;

-transition zones adjoining areas allocated for conservation and restoration under the provisions of section 6.1.2.

The following may not be included:

-care-demanding areas and transition zones normally demarcated when feling is carried out;

-areas that have been sold for nature conservation purposes (nature reserves etc.). (However, a proportion corresponding to areas that have clearly been voluntarily allocated with no, or purely symbolic, compensation covered by such nature reserve agreements may be included.)

6.1.3 When forestry management on landholdings where areas asper section 6.1.1 a and b above (for which the landowner has not received financial compensation) significantly exceeds 5% of the productive forest land area, the appropriate quantitative parts of the standard could be adjusted in agreement with the certifier.

6.5.7. Dead wood, except for smallwood felling residue, is to be protected from forest measures unless there is a documented risk of the mass reproduction of pest insects.

- Windthrown seed trees/shelterwood trees and standing spruce infested with large bark beetles (Ips typographus) may be removed provided the conditions set out in Section 6.5.8 below are fulfilled.

- Fresh windfalls may be removed from stands where the average volume exceeds 3 m^3 per hectare provided that some representative windfalls per hectare are retained. Where the volume of windfalls is less than 3 m^3 per hectare, single, especially valuable and easily accessible windfalls may, in exceptional cases, be extracted, provided that the corresponding volume of larger dead wood is created.

In forest close to populated areas, measures may be taken to enable accessibility and to improve safety.

***6.5.8**. Standing dead wood, such as high stumps, of common deciduous and coniferous trees should be created when thinning and regeneration felling. Some fallen trees representative of the stand may be left per hectare, either actively or passively, during the regeneration phase.*

APPENDIX 2 Assessment of forest biodiversity potential

ASSESSMENT OF FOREST BIODIVERSITY POTENTIAL

SITE	E	F	S	B	W	C
1. Conspicuously broken terrain / varied topography	○	○	○	○		○
2. Vertical cliff / scree-slope > 10 m high		○	○	○		
3. Forested gorge / ravine > 10 m deep	○	○	○	○	○	○
4. Site characterised by S - SW facing slope steeper than 15% (3:20)		○		○		○
5. Site characterised by N – NE facing slope steeper than 15% (3:20)			○			
6. At least part of the site located above 450 m. altitude / prealpine			○			
7. Site surrounded by forest / terrain buffering local climate			○		○	
8. Site characterised by normally wet / very wet forest			○		○	
9. Area > 0,1 ha of forested rocky outcrop / ground with very shallow soils	○	○		○		○
10. Lichens cover > 50 % of the ground		○				
11. Site characterised by a conspicuous herb component / *Ribes* / *Lonicera*	○	○	○	○	○	○
12. Lime- / hyperite-rich soils / conspicuous amounts of orchids / liverworts	○	○	○	○	○	○
DYNAMICS						
13. Signs of former - recent forest fire on stumps / trees	○	○				○
14. Several living trees with fire-scars	○	○				
15. Several living trees with scars from more than one fire	○	○				
16. Recently burnt area > 0,1 ha with substantial amounts of living / dead trees	○	○				
17. Forest area > 0,1 ha unaffected by a recent radical disturbance	○					
18. Spruce constitutes less than 10% of the stand volume / basal area		○		○	○	
19. Several canopy gaps less than 0,1 ha with natural regrowth of main species			○	○	○	
20. Site characterised by a thick, continous moss cover on rocks and boulders			○	○	○	
21. Conspicuous signs of woodpecker activity on living trees / dead wood	○	○	○	○	○	○
22. Seasonally inundated arrea >0,1 ha in forested surroundings			○	○	○	○
23. Signs of beaver activity	○				○	
24. Signs of former - present grazing / meadow mowing / pollarding / coppicing				○	○	○
25. Present grazing / meadow mowing / pollarding / coppicing						○
HABITATS						
26. Boulder terrain > 0,1 ha / large boulders > 2 m high	○	○	○	○		○
27. A total of > 0,1 ha sandy, sun-exposed, sparsely vegetated ground	○	○				○
28. Shaded > 2 m high conspicuous vertical cliff with a mixed moss cover	○	○	○	○	○	○
29. Area > 0,1 ha of normally wet / very wet forest	○	○	○	○	○	○
30. Area > 0,1 ha of wet / very wet, conspicuously sloping forest	○		○	○	○	
31. Area > 0,1 ha dominated by luxuriant herbs / tufted ferns			○	○	○	○
32. Forest in contact with open water / wetland > 0,1 ha	○	○	○	○	○	○
33. Spring / spring brook in forested surroundings	○	○	○	○	○	○
34. Non-seasonal brook / watercourse in forested surroundings	○	○	○	○	○	○
35. As above, and meandering in sand / silt	○	○	○	○	○	○
36. White-water / rapids / waterfall in forested surroundings			○	○		
37. Open / semi-open, non-cultivated grass- / herb- / heath-area > 0,1 ha						○
38. Conspicuous, sun-exposed forest brow with herbs / shrubs	○			○	○	○
39. Conspicuous hollow tree / nest of coarse twigs / several nesting holes	○	○	○	○	○	○
40. Hollow tree > 40 cm with a major cavity in the trunk	○			○		
General Swedish version — **SITE SCORE**						

TREES	E	F	S	B	W	C
41. Several > 2 m high hazel / yew	○		○	○		
42. Substantial amounts of > 2 m high junipers / shrubs	○			○	○	○
43. As above / hazel and in open, sun-exposed conditions						○
44. Several hawthorn / whitebeam / crab apple / gean / buckthorn > 10 cm	○					○
45. Substantial amounts of aspen / sallow / rowan / black alder / oak > 10 cm	○	○			○	
46. Substantial amounts of elm / lime / maple / ash > 10 cm	○		○	○	○	
47. Substantial amounts of broadleaf trees > 20 cm	○	○	○		○	
48. Several elm / lime / maple / ash > 40 cm				○	○	○
49. Several broadleaf trees > 40 cm	○	○	○			○
50. Several trees > 40 cm	○	○	○	○	○	○
51. Substantial amounts of trees > 40 cm	○	○		○	○	○
52. Several trees > 60 cm	○	○	○	○		○
STRUCTURE						
53. Trees > 10 cm characterised by a conspicuous girth / age variation		○	○	○	○	○
54. Several trees stand out as consp. older / larger than the stand in general	○	○		○	○	○
55. Several trees with conspicuously thick branches and low / wide crowns	○	○	○	○	○	○
56. As above and in open, sun-exposed conditions	○	○				○
57. Several solitary trees > 60 cm	○					○
58. Substantial amounts of conspicuously retarded / stunted trees > 10 cm	○	○	○		○	○
59. Substantial amounts of formerly - recently snow-broken trees > 10 cm			○			
60. Substantial amounts of basally multi-stemmed trees / coppice > 10 cm		○			○	○
61. Substantial amounts of trees on buttresses			○	○	○	○
62. Several stems with conspic. occurrences of mixed mosses / lichens / *Lobaria*	○	○	○	○	○	○
63. Several trees with conspicuous occurrences of pendulous lichens		○	○		○	○
64. Substantial amounts of trees with consp. occurrences of pendulous lichens			○			
65. Open / semi open canopy / several conspicuous anthills						○
DEAD WOOD						
66. Conifers; several erect dying / dead trees / > 2 m high stumps > 20 cm		○	○		○	
67. As above and in sun-exposed conditions	○	○				○
68. Broadleaves; several erect dying / dead trees / > 2 m high stumps > 20 cm	○	○	○	○	○	
69. As above and in sun-exposed conditions	○	○		○		○
70. Substantial amounts of erect dying / dead trees / > 2 m high stumps > 20 cm	○	○	○	○	○	○
71. Several windthrown trees with upturned roots	○	○	○	○	○	
72. Several rot-broken trees			○	○	○	
73. Several downlogs > 20 cm.	○	○	○	○	○	○
74. Several downlogs > 20 cm in open sun-exposed conditions	○	○				○
75. Several downlogs > 20 cm with a mixed, partly velvety moss cover			○	○	○	
76. Several downlogs > 20 cm in various stages of decay		○	○	○	○	
77. Substantial amounts of downlogs > 20 cm	○	○	○	○	○	
78. Several downlogs > 40 cm	○	○	○	○	○	○
79. Several trees / stumps / logs with conspicuous occurrences of fungi	○	○	○	○	○	○
80. Subst. amounts of trees / stumps / logs with conspic. occurrences of fungi		○	○	○	○	
Skogsbiologerna AB © 2001 Excel — **STAND SCORE**						

APPENDIX 3 Formulas for the calculation of the dead wood

- Volume for dead trees (snags or lying), with full canopy; where the canopy is partially lost the following reduction was applied:
  - 15% of the total volume if the crown left was between 51% and 99%;
  - 30% of the total volume if the crown left was between 1% and 50%.

The following formulas were taken from an analogous study (Personn and Westgård-Panic, 2007).

V=volume (m^3)

Dbh= diameter breast height (1.3 m) (cm)

H= height (m)

Beech, ash and elm:

$V=(0.01696\times dbh^2+0.1237\times dbh^2+0.00047\times dbh^2\times h+0.006222\times dbh\times h^2)/1000$

Oak:

$V=(0.03913\times dbh^2\times h+0.04905\times dbh^2+0.08772\times dbh\times h)/1000$

Birch:

$V=(0.1432 \times dbh^2+0.008561\times dbh^2+0.02180\times dbh\times h^2-0.06630\times h^2)/1000$

Aspen and Cherry:

$V=(0.01548\times dbh^2+0.03255\times dbh^2\times h+0.000047\times dbh^2\times h^2-0.01333\times dbh\times h+0.004859\times dbh\times h^2)/1000$

Norway spruce:

$V=(0.1104\times dbh^2+0.01935\times dbh^2\times h+0.01815\times dbh\times h^2-0.04936\times h^2)/1000$

Scots pine:

$V=(0.1072\times dbh^2+0.02427\times dbh^2\times h+0.007315\times dbh\times h^2)/1000$

- Part of standing tree or high stumps, Huber's formula:

V= volume (m^3)

d_m= mid diameter (m)

l= length (m)

$$V = \frac{\pi}{4} \times d_m^2 \times l$$

- Part of lying dead tree (small coarse woody debris) Andersson (1995) in Malin (2002):

$$V = \frac{\pi}{4} \times \left(d_b^2 \times 0.485 + d_t^2 \times 0.515 \right) \times l$$

V= volume (m^3)

d_b= bottom diameter (m)

d_t= top diameter (m)

l= length (m)

APPENDIX 4 Nature classes classification

Determine the nature Class 1-4

(from Guidelines for the coupling of nature assessed areas to målkoder - *Handledning för koppling av naturvärdesbedömda områden till målkoder* Börje Drakenberg/AB Skogsbiologerna. Mars 2001)

Maximum score in each biotope group is in theory 50 but this level calls for impossible combinations of structures and/or substrates since the groups have to encompass a variety of stand types. In practice a little over 30 is therefore the maximum score. Stands with a score around or over 20 are very rare and have a high biodiversity potential; any stand with a score around 15 can be considered to be important for biodiversity. Stands scoring below 6-8 can normally be considered of less importance for biodiversity - though elements in these may call for modifications in a forestry operation.

1: about 20 points or above with reference to "hot" points - very high nature of the rule corresponding key habitat, the items will normally always be assigned classes NO or NS.
2: between approximately 20-13 p taking into account the 'hot' points - high nature, are normally key habitat quality or can develop them with appropriate care or lack of such.
3: between about 13-9 p with regard to the "hot" points - Relatively high natural values. Pine forest with this score is very rare and may already at this point level to be of key habitat quality.
4: for about 5-8 P - Low natural values, however, note that a low mark was given object can contain light elements such as demanding streams, lodväggar; mm thick trees.
Suggest "best" classification

	N	O	S	B	W		C
					Undrained	Drained	
1	NS	NO	NO	NO/NS	NO	NS	NS
2	NS	NO	NO	NO/NS	NO	NS	NS
3	NS/PF	PF/PG	PF/PG	NS/PF	NO	PF	PF
4	PG	PG	PG	PF	PF	PF	PF

N – Newly disturbed sites; fire fields, clearcuts, flood reas all in young phases of succession

O- Often: Extensively fire disturbed sites normally with pine or pioneer broadleaf forest in older phases.

S- Seldom: Small scale, canopy gap disturbed forests normally dominated by spruce with an in mix of other trees.

B- Broadleaf forests disturbed on small scale by canopy gaps with beech, elm, lime, maple, ash mixed with other trees**.**

W- Water disturbed swamp forests with alder, birch or sallow.

C- Forests in the **C**ultural landscape disturbed by grazing / mowing normally with a mixed forest of oak, conifers and other broadleaves.

APPENDIX 5 Tree species composition (in percentage) of each stand surveyed

	Species composition																							
	set aside												non set aside											
	P	S	Bi	Be	O	OB	P	S	Bi	Be	O	OB	P	S	Bi	Be	O	OB	P	S	Bi	Be	O	OB
a	10	10	70	10	0	0	20	0	40	30	0	10	90	1	9	0	0	0	70	0	30	0	0	0
b	0	0	0	30	70	0	0	0	20	0	0	80	2	3	85	4	1	5	0	0	5	0	90	5
c	5	5	90	0	0	0	0	0	0	95	5	0	5	5	90	0	0	0	0	0	50	0	0	50
d	0	30	0	0	0	70	0	0	10	50	40	0	0	0	0	80	20	0	10	0	10	0	70	10
e	80	1	19	0	0	0	0	0	10	0	0	90	0	0	2	95	2	1	1	4	15	5	70	5
f	0	0	15	40	40	5	0	10	90	0	0	0	0	0	0	99	1	0	0	0	0	100	0	0
g	0	0	15	5	0	80	30	20	50	0	0	0	0	0	0	100	0	0	0	100	0	0	0	0
h	0	0	10	0	0	90	0	0	0	99	0	1	0	0	0	100	0	0	65	0	0	30	5	0
i	0	0	5	5	90	0	0	0	0	0	0	100	0	0	30	0	0	70	0	0	40	0	0	60
j	0	0	0	70	30	0	0	0	0	80	20	0	0	0	0	70	30	0	0	0	0	100	0	0

In the first left column, the letters indicate the estates

P= Scots pine *Pinus sylvestris* L.

S= Norway spruce *Picea abies* (L.) Karst

Bi= birch *Betula pendula* Roth

Be= beech *Fagus sylvatica* L.

O= Oak *Quercus robur* L. and *Quercus petraea* (Mattuschka) Liebl.

OB= other broadleaves (ash *Fraxinus excelsior* L., sycamore *Acer pseudoplatanus* L., cherry *Prunus avium* L., lime *Tilia cordata* Mill.)

APPENDIX 6 Stands description

a

The two set aside stands were chosen for different reasons: one because it was a path of old grown hazel coppice and the other because in the management plan it presented a mixture of four broadleaved species. The two non set aside areas were the two oldest stands in the estate with more than 100 years. From the data elaboration it resulted that the highest amount of dead wood was in one non set aside stands, while the scores of the biodiversity potential were higher in both set aside stands. Different indicators of ecological value are at times better in non set aside part (age and dead wood) and some others in set aside (biodiversity potential and structure). The set aside area correspond to 7% of the whole estate, so there is no need from a certification point of view to add more, and I retain that a good choice was made. Yet the lack of large trees could be a good reason for setting aside a part of the old non set aside stands, considering also its mixture of species.

b

The two set aside stands have quiet different features: one was a 120 year old oak-beech stand, with a fairly interesting structure; the other was a birch-alder stand, located in a boggy area, where no management at all was planned. One of the two non set aside stand was relative old if compared to other stands, with a open field in the surrounding and a brook on one border; the other was characterized by a mixture of broadleaves and conifers, with a varied vertical structure. The highest amount of dead wood was observed in the second non set aside stand, followed by the first set aside stand. The highest score of biodiversity potential was even in the two oldest stands (one for each category). No coarse trees recorded. In this estate it appeared that one of the two set aside stands could have been replaced by a more ecologically valuable non set aside one, a fact that was confirmed also by the field survey. Furthermore, still the common lack of large trees is, once again, a good factor to consider for the future structure of the landscape, therefore it should be considered more in the certification process.

c

The smallest estates investigated, with 7% of set aside area. The first set aside stand was an old birch forest, in a rather wet land with a low productive level, but presenting the highest amount of deadwood; the other set aside site, a mature beech and oak forest, was surrounded

by a small river and presented in one side, a broken terrain with a varied topography, with the highest biodiversity potential score. The non set aside parts instead were both dominated by noble broadleaves in mixture with birch, both crossed by a small river and presenting a discrete amount of dead wood, yet not standing out due to special ecological values. Thus for this estate I would say that a good balance between production and biodiversity purposes was accomplished.

d

The two set aside stands presented a good mixture of tree species, where broadleaves were dominant and they were among the oldest set aside stands; furthermore they were chosen because of their closeness, constituting a certain level of forest continuity. From the field survey it appeared that the first was located in a rather swampy area, with a clear image of decaying forest; the second had a very nice vertical structure and mixture of species, hosting large beeches (>65 cm); the problem here was the massive colonisation of Norway spruce, which in the long term could take over the broadleaves, as no management is planned. Similarly, the two non set aside stands were constituted of both mature coniferous and broadleaved trees; in the first stand were recorded signs of woodpecker activity, while the second presented oaks and Scots pines with large diameters. The data analysis showed that the two set aside stands had the lowest amount of dead wood but had the highest scores in the biodiversity potential survey. All stands presented valuable characteristics to be set aside; therefore it is difficult to make a comment on whether or not the best sites were chosen. The non set aside stands occupy a large territory, thus could be an idea to divide them and set aside the parts with interesting features (*e.g.* large trees, woodpecker activity).

e

The two set aside stands are both classified as NO stand, left to completely free development, low productive stands in both cases boggy areas; one with a fairly good mixture of broadleaved trees. The two non set aside stands were the oldest in the whole estate, with a good mixture of broadleaved species, in both cases presented the highest amount of deadwood. Also, even though in all four stands the biodiversity potential score was high (>9), it was highest in non set aside stands; furthermore, one was confining with an open field, thus important as transition and ecotone zone. Despite the fact that 16% of the total area is set aside, higher by far than the average and certification limit, looking at all the indicators of

ecological value they suggest that the choice could have been done in a better way, considering these two non set aside stands examined.

f

This estate differed from the others because of its marked fragmentation; in fact it was spaced out from agricultural land. The first set aside stand surveyed, was a small forest of different broadleaved species, like oak, beech, alder, cherry and birch often with large diameters; it presented the highest amount of deadwood and confined with an open land, so important as an ecotone zone. The other non set aside stand covered a large area (11,4 ha), mainly constituted by birch and spruce, left to natural development. The first non set aside stand was a long and narrow patch along a small river, characterised by great slope with vertical cliffs on the sides; many downlogs, large trees mainly beech, most of those carrying *Fomes fomentarius*; from the results it had the highest biodiversity potential score. The second non set aside is a mature beech forest, with some dead trees probably wind fallen: generally it could be said that it had low ecological value, as it appeared as a standard productive forest. Combining field survey and results, it seems that in the non set aside stand should be reconsidered in the future certification, as it resulted to have very high ecological values and rare characteristics (ravines); as far as the set aside areas are concerned, it seems that one was worth preserving, while the other presented a low productive level, thus classified as set aside, even though it presented a quite good biodiversity potential. In my opinion priority should have been given to other sites.

g

The parts set aside in this estate were chosen, among others, for the older age and good mixture of at least four tree species, comprehending both conifers and broadleaves; one was crossed by brooks and a small river. The non set aside were retained to be the best from an ecological point view due to mature age (>100) and crossed by a stream and, in the other case, for the high heterogeneity of the species composition along with age, if compared to other stands. No coarse trees were recorded. Once again in this estate the ecological indicators inventories supported at times set aside and other times non set aside. The highest amount of dead wood was found in the set aside stands, while the second one was in a non set aside. The contrary for the score of biodiversity potential, where 13 points were assigned to a non set a aside stands, while 12 points to the set aside one (two highest scores). Personally, I retain that

a fair choice was made in this estate, even though some data might suggest not so. The field survey showed more interesting features in stand structures and locations that gave more credit to the set aside area. However it is a matter of fact the large trees are lacking, therefore it could be advisable to consider older stands to start the slow process for creating old ancient woodland.

h

The two set aside stands chosen in this estate were entirely composed by broadleaved tree species; the first one was crossed by a small brook, located in a wet area, while the other presented a varied topography, in a slope crossed by a brook, with several downlogs and old trees, mainly beech and alder. The first non set aside is a mature beech forest, with several wind fallen trees; the second was constituted by a nice mixture of coniferous and broadleaved tree species, mainly Scots pine, beech and oak, with a diversified vertical structure. Through data elaboration it turned out that the first non set aside stand had the highest volume of deadwood, while the second set aside stand had the highest biodiversity potential. With this information and the field survey, it appeared that a very valuable stand was set aside and some non productive forest land were set aside; this could be done in a better way, since some other sites with high potential values could have been included instead.

i

Both set aside stands presented a total composition of broadleaved tree species, where one stand was monoculture of alder, in a rather swampy area; the other is old (120 years) if compared to the other set aside stands. The two non set aside stands were chosen because they were the oldest, presenting in the management plan only broadleaved species and, in one case, with a diversified composition of different noble tree species and, in the other case, it was crossed by a brook. Here again, the total amount of deadwood was higher in both non set aside stands, while the highest score of biodiversity potential was in one set aside stand and the second in a set aside one. No coarse trees were recorded. From the results in seems that there could have been a different criterion in setting aside those areas, but from the field work survey it resulted that also the non set aside stands were not particularly adept or relevant for ecological values. This was the largest of the ten estates, rather fragmented, thus it was not entirely visited; consequently it could be that better stands were not taken into consideration. However, just considering this inventory, different stands could have been set aside.

j

The two set aside stands were both older than 100 years and according to the management plan, entirely composed of broadleaved species. From the survey, it resulted that one stand was left to free development, but it has been colonised by Norway spruce; its topography is quite heterogeneous, presenting a small canyon with broken terrain. The other set aside stand had a nice structure, with a consistent amount of dead wood, presenting the decaying fungus *Fomes fomentarius*. The two non set aside stands were chosen because of the broadleaved tree composition and age; one was a beech forest, the other one presented a mixture of beech, oak and birch mainly, where many high stumps carried *Fomes fomentarius*. From the forest mensuration, it resulted that this last stand had the highest volume of deadwood, followed by the two set aside stands; it also had the highest score in the biodiversity potential, followed by the two set aside stands. From the results and the field survey it could be said that two valuable sites were set aside, but one of the non set aside stands chosen presented higher ecological value. In this estate, it is my opinion that a good choice was made, but still some more interesting parts were left out.