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Finnish family forest owners' retention tree management behaviour

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Abstract

In Scandinavia a widely adopted biodiversity maintenance measure in managed forests is to leave retention trees to the clearcutting areas. A certain number of retention trees are left to the cutting area permanently as residual trees, which distinguishes them from shelterwood and seed trees. The aim is to increase the amount of large-diameter decayed wood in managed forest stands throughout their different development stages. However, there is evidence that some forest owners have removed the retention trees. The attitudes of forest owners in Finland towards biodiversity issues in managed forests and their knowledge and behavior concerning retention tree management were studied based on two surveys conducted in 2001 and 2006. In general, forest owners' attitudes were positive but their level of knowledge on biodiversity issues was moderately low. There were no significant change in forest owners´ attitudes and the level of knowledge between the two succeeding surveys. A sample of clearcutting areas was measured in order to find out if retention trees had been removed during a decade after the clear-cut. According the results some retention trees had been removed from every third of the inspected cutting areas. All the retention trees were harvested only from four percent of the areas. Received forestry extension and better knowledge on biodiversity issues decreased the likelihood to remove the retention trees.

Keywords: Biodiversity, forestry extension, forest management recommendations, non-industrial private forest owners, retention trees

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1 Introduction

The two principal instruments for safeguarding forest biodiversity are protection of the most valuable forest ecosystems through establishment of conservation areas and the management of forest stands in a way that takes biological diversity into account. Since the Rio Declaration in 1992, principles enhancing ecological sustainability have been widely adopted into forest management practices in Scandinavia. For example in Finland, the forest management recommendations, i.e. the guidelines for managing private forests, were amended first in 1994, again in 2001 and lastly in 2006. The Forest Act and the Nature Conservation Act were amended in 1996, and at the end of the year 2000 forest certification had been adopted throughout the private forests.

In practice, the effect of the changed goals and management principles in commercially managed forests has been twofold. First, certain small valuable habitats (like forests near streams, ponds, lakes or springs, small herb-rich forest patches and ravines and steeps) have to be set aside or managed so that their characteristics are preserved when forest stands are felled or otherwise managed. Second, certain structural characteristics have to be maintained when forests are regenerated. Among these characteristics, the most important are retention trees.

In regeneration cuttings a certain number of retention trees are left as permanent residual trees, which distinguishes them from shelterwood or seed-trees (Vanha-Majamaa and Jalonen 2001). The aim is to increase the amount of large-diameter decayed wood in managed forest stands throughout their different development stages. More accurately, the objective is to i) lifeboat species and processes over the regeneration phase; ii) increase structural variation in the stand; and iii) enhance connectivity on a landscape level (Franklin et al. 1997, Vanha-Majamaa and Jalonen 2001). Therefore, in regeneration cuttings it is important to pay attention to diversity, amount, and temporal and spatial continuum of the retention trees that will in the future form important part of the stand's decayed wood (e.g. Siitonen 2001a, 2001b).

The amount of decayed wood produced by the retention trees is very small compared to the amount of decayed wood in unmanaged natural forests. The degree to which biodiversity really benefits from rather small amount of retention trees is still unclear (e.g. Siitonen 2001b, Vanha-Majamaa and Jalonen 2001). However, preliminary results of Siitonen et al. (2006) indicate that retention trees increase significantly diversity of species on regeneration areas but their number usually is too small to enhance endangered species. The studies concerning man-made high stumps indicate that they are valuable habitats for many saproxylic species but also felled wood is needed (Jonsell and Weslien 2002, Jonsel et al. 2003, Lindhe and Lidelöw 2004, Lindhe et al. 2004).

The living retention trees may have also negative impacts on managed forests. They may hamper regeneration and decrease the increment of new tree generation (Valkonen et al 2002), and increase the occurrence of forest pests (e.g. Martikainen et al. 2006). However, the recent studies indicate that large groups of retention trees may provide an alternative food source for pine weevils, and may consequently reduce the damages caused by pine weevils on pine seedlings (Pitkänen et al. 2008).

Both the criteria of the Finnish Forest Certification System (FFCS) and the current Finnish forest management recommendations include instructions on the amount, diversity and location of retention trees. The criterion of the FFCS demands that at least five retention trees should be left onto the cutting area, and the forest management recommendations give instructions for the number, placement and diversity of the retention trees. It should, however, be noted that a demand for retention trees is not included in the Finnish forest law. The existence of retention trees is based on forest owners' voluntary actions, therefore owners' attitudes towards and knowledge on retention trees and their ecological function are fundamental issues.

The amount and quality of retention trees left to cutting areas has been surveyed annually since 1995 by local forestry centres (for more details see Hänninen 2001, Talousmetsien... 2000). The monitoring results show that the volume and amount of retention trees has increased since 1998, and are today on the average 4.0 m^3ha^{-1} and 12–14 stems ha^{-1}after the regeneration cutting (fig. 1). The value of the retention trees has been estimated to be about 150 euros per hectare (i.e. 3% of the net income of harvest), which means approximately 20 million euros annual investment for biodiversity enhancement (Siitonen and Ollikainen 2006). The amount of retention trees left on a regeneration area is, on the average, larger than the certification criterion demand. The quality of the retention trees has also developed positively: the proportion of regeneration areas where the quality of the retention trees has been estimated to be weak or moderate was 9% in 2006 compared to 32% in 1998 (Hänninen and Kurttila 2007).

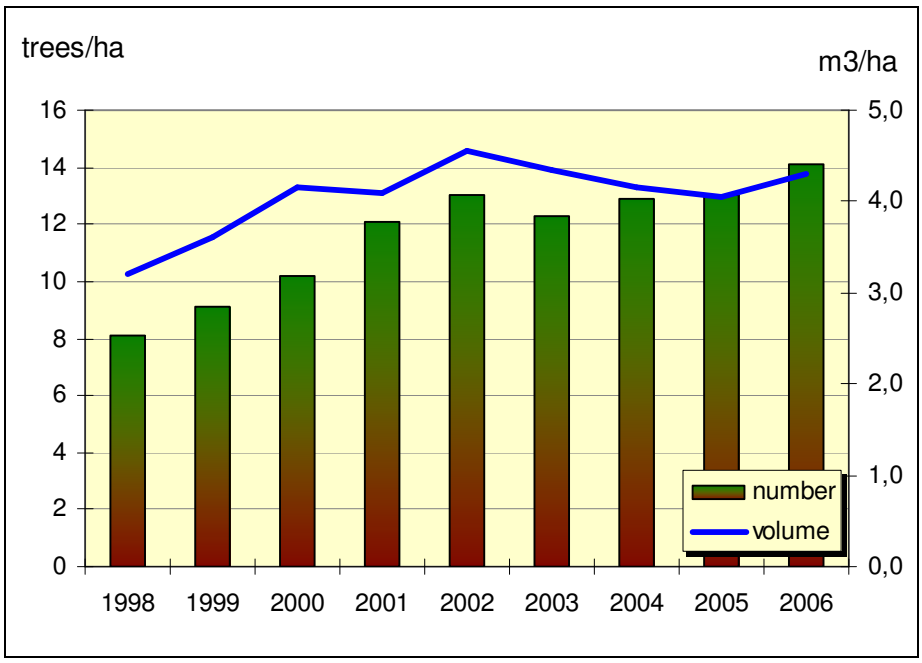

Figure 1. The amount (left axis) and volume (right axis) of retention trees in family forests during 1998–2006 (Hänninen and Kurttila 2007).

Unfortunately, there is evidence that some forest owners have removed the retention trees some years after the felling (Salomäki 2005), a phenomenon which has been noticed also in Sweden (Larsson and Elander 2004). In Finland, family forest owners self-actively carry out certain forest management operations, of which majority are pre-commercial treatments. For example, more than 60% of artificial regeneration, tending of seedling stands and improvements in juvenile stands and energy wood cuttings are carried out by family forest owners themselves (Koho et al. 2004, Karppinen and Hänninen 2006). While doing these treatments there is a risk that some landowners remove retention trees. The earlier studies concerning forest owners' knowledge on the retention tree management showed their understanding being rather poor in the year 2001 (Hänninen and Kurttila 2004, Kurttila and Hänninen 2005). Since then biodiversity issues have been emphasized in forestry extension.

The objective of this study is to find out the attitudes of Finnish family forest owners towards biodiversity conservation in commercially managed forests and their knowledge and behaviour concerning retention tree management. The effect of forestry extension is also evaluated.

2 Materials and methods

2.1 The data

The data consist of two surveys – in 2001 and 2006 –, and two forest inventory in 1998–99 and 2006 (fig. 2). The basic population of the study was private forest owners who had carried out cuttings between years 1996 and 1998. The forestry centres took a sample among the cutting areas of these landowners according to more detailed criteria and inspected the quality of the cutting areas during years 1998 or 1999. This inventory data were supplemented with mail inquiry during spring 2001. The questionnaire form was sent to the 1,048 family forest owners, and the response rate was 55.8% and the usable data included 585 observations. The second survey in the beginning of the year 2006 was addressed only to those 537 owners of the original sample who had left retention trees to the clear-cutting area the response rate being 56.4%.

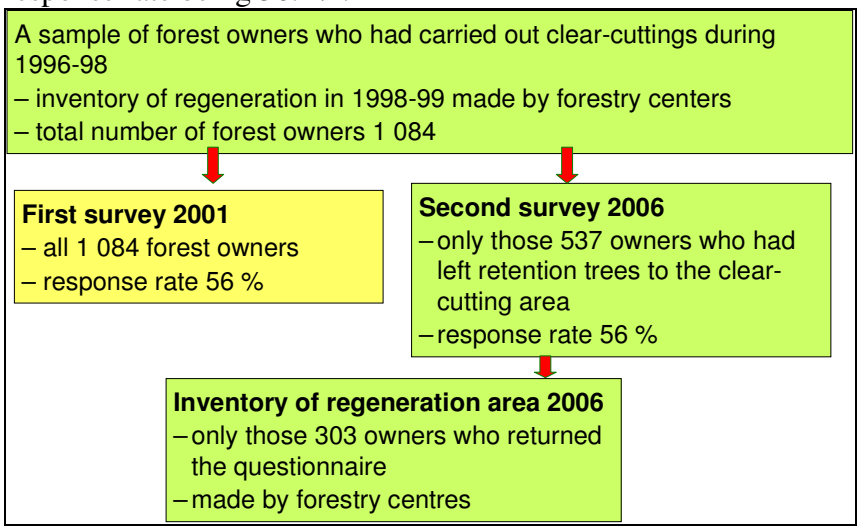

Figure 2. The structure of the data in the study.

In the mail questionnaire of the year 2001, 29 arguments concerning the rules and recommendations included in the Forest Act, official forest management recommendations and the certification criteria were presented to the forest owners. Ten arguments were related to retention tree management issues and only these arguments are examined in more detail in this study. In the questionnaire, the respondents were asked to decide, whether the presented arguments were true or false. In addition, "don't know" answer was possible. The arguments concerning the retention trees were based on official forest management recommendations (Luonnon-läheinen... 1994), forest certification criteria (Suomen metsäsertifiointi…

1999), and publications that relate to retention tree subjects (e.g. Säästöpuut 1998, Kotiharju and Niemelä 2000). In addition, the questionnaire included attitude statements concerning biodiversity conservation, the background characteristics of the respondents, their forest holding characteristics and some information concerning their forest management activities. The questionnaire of the year 2006 was similar than in 2001 but a bit shorter the emphasis being in the retention tree management.

The answers to ten arguments were coded so that correct answer gave one point and wrong and "don't know" answers gave zero points. The forest owners' knowledge concerning retention trees was calculated by summing these points. Based on this sum, the forest owners were then grouped into three groups: lowest quartile "poor knowledge" (x_{25}, the knowledge level that includes 25% of the respondents), highest quartile "good knowledge" (x_{75} that includes 25 % of the forest owners having the best knowledge) and "moderate knowledge" (50% of the forest owners that were located between these two groups).

The regeneration areas were inventoried by local forest center professionals in 1998–99 and again in the summer of 2006. The diversity, number and volume of living and dead standing retention trees and the volume of lying logs were estimated in the both inventories. In the inventory of 2006, also the diversity, number and volume of retention trees felled in storms or removed from the regeneration area, and as an indicator for logging conditions, the distance to the nearest road and dwelling place or summer cottage were estimated.

2.2 Cautions concerning the data

Concerning the interpretation of the results some limitations of the data should be taken into account. Firstly, forest owners have had a relatively short time to become familiar with new rules and recommendations. Forest certification, particularly, was a new thing for family forest owners at the time when the first mail survey was carried out.

Secondly, all of the sample forest owners had made recently regeneration cuttings, which may cause that they based their retention tree knowledge on these practical examples in which logging contractors usually had selected the retention trees. Therefore, the landowners had not yet been forced to consider the ecological function of the retention trees.

Thirdly, the sample of forest owners is not a representative sample from Finnish family forest owners. The results of this study describe the knowledge of forest owners who, on the average, own larger forest holdings and have higher forest management activity than "regular forest owner" (for more details of the sample forest owners see Hänninen & Kurttila 2004). If

the survey had been addressed to all forest owners the knowledge could have been poorer.

Lastly, the presented arguments must have been difficult particularly to those landowners who had managed their forests mainly with the help of forestry professionals (e.g. local forest management associations) or who had made a contract on management with a forest firm. However, the number of missing answers was very small which indicates that respondents had been careful when answering to arguments.

3 Results

3.1 Attitudes towards retention tree management

Forest owners' attitude towards retention tree management was positive in general. More than two thirds of forest owners agreed that it is important to leave some large retention trees to regeneration areas to enhance biodiversity (fig. 3). Only about one fifth didn't consider leaving retention trees to be necessary at all. Almost half of the forest owners regarded aspens as retention trees to be a threat to growing seedlings. More than half the forest owners would require compensation for leaving retention trees into regeneration area. In the survey 2001 forest owners' considered more often that scenery values are not strongly enough taken into account in forest management practices and that it is necessary to leave some large retention trees on the clear cutting area to enhance biodiversity than in the survey conducted five years later (2006).

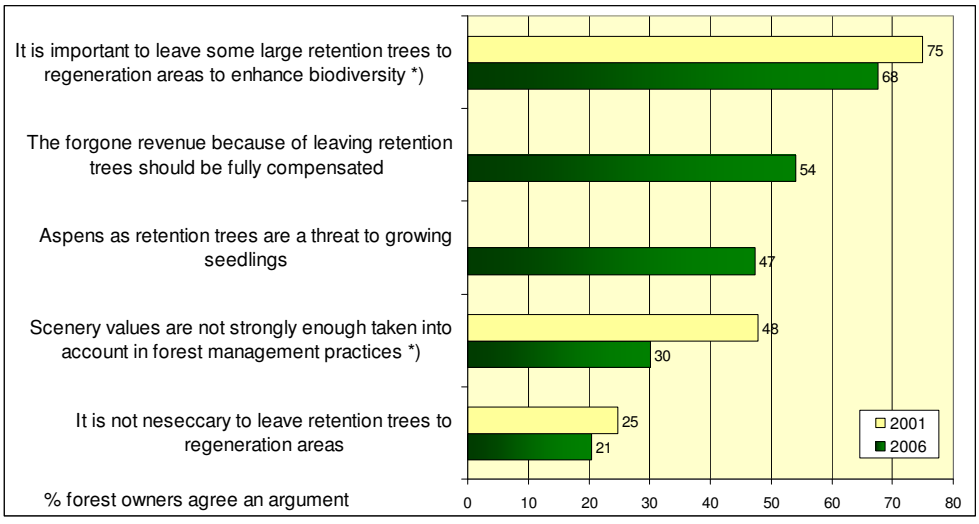

Figure 3. Forest owners' attitudes toward retention tree management in 2001 and 2006 (n_{2001}=569–574, n_{2006}=297–301).

The forest owners who had received forestry extension agreed more often with the argument according to which leaving retention trees is important for biodiversity. This connection between forestry extension and attitudes was found in both surveys, but especially in the one conducted 2006.

All forest owners, whether they have received forestry extension or not, considered that the costs of retention tree management have to be taken into account when cuttings are planned. Consequently forest owners' motives in terms of biodiversity enhancement are not completely altruistic. The costs incurred by retention tree management are relatively small but that fact was apparently not often discussed at all with forest owners.

3.2 Forest owners level of knowledge on retention tree management

Forest owners' knowledge on retention tree management was examined in the questionnaire by presenting arguments which were related to the amount (questions 1 and 2), diversity (3 to 5), setting (6 and 7) and function (8 to 11) of retention trees. The respondents were asked to choose whether the argument was true or false or don't know. The results are presented in the table 1.

The forest owners knew very well the minimum number of retention trees (5 pcs ha^{-1}) demanded in the criteria of the FFCS and recommended in the forest management guidelines. The knowledge was very good also with respect of retention tree diversity recommendations. It was commonly known that snags and windfall trees should be left to the regeneration area, and that large aspens, willows and alders are valuable retention trees.

On the other hand, only about half of forest owners knew that decaying trees and other trees that are not economically important are valuable retention trees. The share of correct answers was significantly lower in the survey conducted 2001. In both surveys almost 60% of the respondents knew that the argument "Stand-alone spruces are recommended retention trees in regenerated spruce stands" was incorrect, whereas only about 40% knew that it is not recommended to leave retention trees evenly over the regeneration area.

The forest owners gave contradictory responses to the arguments related to ecological function of the retention trees. More than half of the forest owners knew that decayed wood is important also in young forests. However, 64% in 2001 and 51% in 2006 thought that retention trees should be removed during pre-commercial treatments or during first commercial thinning. Also the fact that soil preparation should not be carried out beneath the retention tree cluster was not widely known among forest owners (less than half of the respondents gave the correct answer).

Table 1. Forest owners' retention tree knowledge in 2006 and 2001 (the last one in parenthesis). The very well known (more than 60% of correct answers) arguments are shown in *italics*, and poorly known arguments (incorrect and don't know answers more than 50 %) are underlined. T/F means that an argument is true (T) or false (F); RECOMM refers to the forest management recommendation and CERTIF to the forest certification criterion indicating to what the instrument is based on.

Arguments	T/F	Correct answer	Incorrect answer	Cannot say
1. At least 5 retention trees per hectare should be left to the regeneration area (CERTIF)	T	67(63)*	7(13)	26(24)
2. Only trees that were alive at the time of regeneration cutting are counted as retention trees (CERTIF)	T	–(47)	–(29)	–(24)
3. Trees that have low economic value and decaying trees are valuable retention trees (RECOMM)	T	52(45)*	37(47)	11(8)
4. Snags and windfall trees should be left to the regeneration area (RECOMM)	T	78(79)	14(16)	8(5)
5. Large aspens, willows and alders are valuable retention trees (RECOMM)	T	58(60)	29(29)	13(11)
6. Stand-alone spruces are recommended retention trees in regenerated spruce stands (RECOMM)	F	65(59)*	25(28)	11(13)
7. Retention trees should be left evenly all over the regeneration area (RECOMM)	F	43(37)	43(51)	14(12)
8. Existence of decayed wood is not necessary for biodiversity in young forests (RECOMM)	F	58(53)	27(36)	16(11)
9. Retention trees should be removed during pre-commercial treatments of sapling stand or at least not later than during the first commercial thinning (RECOMM)	F	35(27)	51(64)*	14(10)
10. Under the retention tree group soil preparation is carried out similarly as elsewhere in the regeneration area (RECOMM)	F	47(48)	35(37)	18(16)
11. Retention trees felled in storms have to remove from regeneration area in order to avoid the risk of a forest damage (RECOMM)	F	50(–)	32(–)	18(–)

n_{2001} = 567–579, n_{2006}=293–299.

– Not asked in 2001 or 2006. * The difference between 2001 and 2006 is statistically significant (t-test, 5%-risk level).

The forest owners were classified into three groups by calculating the number of correct answers: lowest quartile "poor knowledge" (the group includes 25% of the respondents, the ones who had the lowest level of knowledge), highest quartile "good knowledge" (group includes 25% of the forest owners, the ones having the highest level of knowledge) and "moderate knowledge" (the forest owners who were positioned between these two groups). On the average, all forest owners answered correctly to 5.1 arguments. For the forest owners with poor knowledge the number of correct answers was 2.1 on average, for owners with moderate knowledge 4.9 and for owners with good knowledge the average score was 8.1.

Forest owners were asked if they had received any kind of forestry guidance regarding biodiversity issues or especially retention tree management. The forest owners that had received forestry extension had significantly better knowledge on biodiversity issues than the others (table 2). The ones who had received information also knew the primary reasons for leaving retention trees more accurately. One third of all forest owners and 46% of the ones who had received advices concerning retention tree management were able to recognise the primary reasons to leave retention trees.

In the questionnaire of 2006 forest owners' were asked to list the most important reasons to leave retention trees (table 3). Many forest owners (43%) considered that the reason why retention trees should be left was to increase the number of natural seedlings on the regeneration area. Second most common reason was to leave retention trees for birds and other animals as nest trees. To increase the scenic values came in third. However, only 39% of the owners named the ecologically correct, i.e. primary reasons for leaving retention trees and 61% considered secondary reasons most important.

Table 2. The influence of forestry extension to forest owners level of knowledge on biodiversity issues in 2006.

Forest owner has received information during 2001–2005...	Level of knowledge in biodiversity issues (number of correct answers)	
...regarding biodiversity in general	Yes	5.1*
	No	4.2
...regarding retention tree management	Yes	5.2*
	No	4.1
...on both issues	Yes	5.3*
	No	4.2

* statistically significant, t-test, 5%-risk level, n=294–296

Table 3. Forest owners' opinion on the most important reasons to leave retention trees (in 2006).

Reason to leave retention trees	% of forest owners	
Important for threatened species	22	
To produce decayed wood for micro-organisms	19	39
To diversify tree species structure and age-classes of the forest	16	*primary reasons*
Useful for natural regeneration	43	
Essential as nest trees for birds and other animals	31	61
To improve the aesthetic values of regeneration area	23	*secondary reasons*
Other reasons	4	
Total	- [1)]	100

n= 313. [1)] The share of percent is over 100 because part of owners gave more than one reason.

3.3 Forest owners´ retention tree management behaviour

In the survey conducted in 2006 more than one fourth of forest owners (27 %) admitted that they had removed at least some of the retention trees from their regeneration areas. Two thirds of forest owners' said that they haven't removed retention trees and less than ten percent was not sure. According to the respondents most often they had removed wind falls (59%), living trees (slightly less than a third) and dead standing trees (about ten percent).

Forest owners who had removed retention trees were asked the reasons for that operation. The reasons were classified into three groups: economic, silvicultural and others. Almost half (46%) of those forest owners stated that retention trees were removed for economic reasons: valuable material has to be utilized for firewood or sawn timber. Every tenth forest owner had collected retention trees as a fuel. One third of forest owners said that they have removed the retention trees for silvicultural reasons. Most common argument was that the retention trees must be removed because the seedlings in the regeneration area are full grown. Forest owners' strongly supported the statement that one purpose of retention trees is to increase the number and quality of seedlings. These results indicate that the difference between retention trees and seed trees is not clear to the forest owners. Some (4%) of the forest owners considered that retention trees hinder the

growth of the seedlings in the regeneration area and that is why they should be removed.

Table 4. The percentage of the regeneration areas on which the number or volume of retention trees has decreased more than 20% during the inventories 1998–99 and 2006.

	Living retention trees	Large living retention trees ($d_{1,3}$>20cm)	Small living retention trees ($d_{1,3}$=10–20cm)	Dead retention trees (fallen trees, snags)
Decreased number	25	29	18	33
Decreased volume	27	28	20	36

Less than one fourth of the forest owners mentioned other reasons for retention tree removal: most common of these reasons was that wind has fallen down the trees. This indicates that at least all of the forest owners haven't understood that dead and decaying retention trees are especially valuable for biodiversity.

According to the inventory at least some retention trees were removed from one third of the clear-cutting areas. However, all the retention trees were harvested only from 4% of the regeneration areas.

Sometimes it was difficult to observe the retention tree harvesting in the area. There were many uncertainties in the evaluation of the current number of retention trees left compared to the situation right after the clear-cut. Therefore the change was estimated by using a threshold value: if the number of retention trees had decreased more than 20% during the first inventory in 1998–99 and the second one in 2006 it was assumed that at least part of the retention trees have been harvested. By using the 20% limit assessment method it was found that the number of living retention trees was decreased on one fourth of the regeneration areas (table 4). Large diameter retention trees and wind falls or snags were both harvested on one third of the areas.

3.4 The factors affecting the likelihood to remove the retention trees

The characteristics of forest owners and forest holding didn't have effect to the likelihood to remove retention trees. Only differences observed were that the number of dead retention trees had decreased more often in the forest holdings owned by heirs and more seldom in the forest holdings larger than 100 hectares.

The location in vicinity of a dwelling place or a summer cottage decreased the likelihood to remove large retention trees. This can possibly be explained by willingness to retain the trees near inhabited areas because of scenery values. Ylikoski et al. (2004) have found the same result in their study concerning the probability for regeneration cuttings. As expected, location near by a road increased the likelihood to harvest retention trees.

Forestry extension seems to influence into forest owners' likelihood to remove the retention trees: the regeneration areas in which the number of retention trees had decreased were slightly less often owned by forest owners who had received forestry guidance, however, the difference was not statistically significant.

Higher level of knowledge decreased in general the likelihood to remove the retention trees. However, only in one case the difference between groups was statistically significant: forest owners in the group "good knowledge" had more rarely removed dead retention trees.

4 Discussion

Forest owners' attitude towards retention tree management was positive in general. More than two thirds of forest owners agreed that it is important to leave some large retention trees to regeneration areas to enhance biodiversity.

Forest owners answered correctly only to half of the arguments concerning retention trees. Forest owners' knowledge on biodiversity issues was good in respect of retention tree diversity and minimum number recommendations. Their knowledge on the ecological function of retention trees, instead, was quite poor. It is obvious that owners need more ecological justifications for retention tree management – the reasons why retention trees are valuable for biodiversity.

More than one fourth of forest owners said they had removed some retention trees, usually wind falls, from their regeneration areas. The results of the inventory verified that. At least some retention trees were removed from one third of the inspected clear-cutting areas; however, all the trees were harvested only from 4% of the areas.

Forest owners had removed retention trees for economic, silvicultural and other reasons. Economic reasons were the most common ones. Many forest owners considered that the reason why retention trees should be left was to increase the number of natural seedlings in the regeneration area. It seems obvious that landowners mix retention trees and seed trees used in natural regeneration. They also over-emphasize scenic impacts of the retention trees which could explain why so many fallen retention trees, which do not have scenic value, had been removed (on

landowners' valuation of the retention tree attributes see Tönnes et al. 2004). If forest owners do not understand the ecological function of the retention trees or if they emphasize more the landscape function of the trees, there is a risk that they will remove the retention trees during later silvicultural operations. Naturally, larger amounts of fallen conifer retention trees may increase also a risk for forest damages, which can be one reason for caring forest owner to pile them up. Leskinen (2004) found out that part of forest owners eschew retention trees, think that they are waste of resources and are ready to use them, e.g. as firewood. Based of long-term forestry tradition of family forest owners this may even be considered as rational choice.

The characteristics of forest owners and forest holding didn't have much effect to the likelihood to remove retention trees. The location in vicinity of a dwelling place or a summer cottage decreased the likelihood to remove large retention trees. As expected, location near by a road increased the likelihood to harvest retention trees.

Forest owners' assumption on the costs of biodiversity enhancement varies largely. However, the value of the retention trees can vary a lot between regeneration areas. In principle, the retention trees can be trees that do not have commercial value at all. Alternatively, their value can be considerably high in some other cases. It is important that the loss of net income due to retention tree management should be clearly informed to forest owners, particularly in cases when more than the minimum recommended amount of retention trees is considered.

The effects of forestry extension were positive. The forest owners who had received forestry guidance with one way or other had more positive attitudes toward retention tree management, their level of knowledge was higher, and the likelihood to remove the retention trees was slightly lower but not statistically significant. The ones who had received information also knew the primary reasons for leaving retention trees more accurately. Despite of the extension services offered by forestry professionals during the five-year time period, forest owner's level of knowledge has improved only slightly. The attitudes toward retention trees were even worse than in the year 2001.

The forestry organizations that help and advice forest owners should, in addition to operational recommendations, also emphasize the ecological function of the retention trees. The amount and quality of retention trees, or more generally the biodiversity maintenance in private forests, may in practice depend more on the forest owners' forest management goals than on the knowledge and strict implementation concerning the minimum requirements specified in instructions. The requirements do not take into account differences in owners' forest management goals. The general development of forest management planning towards more goal oriented decision support, however, can alleviate this problem.

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