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Abundance and diversity of birds in forests with different management goals

Skogsfåglars riklighet och mångfald i olika målklasser

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1. ABSTRACT

Research shows a negative relationship between biodiversity and intensity of forest management in boreal environments among others. In Swedish forest management the stands are divided into different management types. Two of them focus on wood production while the other two have a greater focus on nature conservation. This study compares the differences between the management types in terms of the diversity and abundance of forest birds. The data was collected through bird surveys, during three separate spring weeks in 2012, during the months March, April and May in Färna Ekopark, located close to Skinnskatteberg in Västmanland, south-central Sweden. In addition to looking at a general pattern concerning the above relationship, the data was also analyzed separately for four different categories of birds: indicator species, cavity-nesters, resident birds and migratory birds. In the case of overall forest bird community, an ANOVA test was performed to see if the results were statistically significant. The results from all analyses showed that management type NS (active management to enhance biodiversity values) had the highest diversity (expressed by species richness) and abundance of forest birds. Hence, to obtain a more diverse and abundant level of forest birds, more stands should be managed as NS stands.

2. INTRODUCTION

2.1 Forest birds and their habitat

Research on forest management in boreal forests shows its negative impact on biodiversity (Helle and Järvinen 1986; Mladenoff et al 1993; Brotons et al 2002). In order to estimate this effect and propose management solutions that would allow for more sustainable use of forests, the intensity of silviculture must be compared with biodiversity as the response variable. Measuring forest biodiversity is, however, a time intensive and expensive process (Lawton et al 1998). A good way to measure it is to use different proxies for biodiversity including indicator species (Lindenmayer et al. 2000). Birds are among those groups of organisms that are easy to survey with a multispecies approach, since even if they cannot always be seen they can often be heard (Bibby 1999).

Nature is never dormant but always shifting through different disturbances and successions. These processes are often slow and/or sporadic (Pennanen 2002). Forest fires and windstorms are two examples of so called natural disturbances that contribute to biodiversity in boreal forest (Hanewinkel et al 2008). Today there are fewer fires and after a windstorm most of the fallen trees are removed which means there is a lack of natural windthrows. In general, a consequence of the decrease of windthrows and dead wood is fewer invertebrates, which negatively affects the forest birds since they then have less to eat. (Zmihorski and Durska 2010; Siitonen 1994).

The way Scandinavian forests are managed today is in some ways attempting to resemble natural disturbances, but compared to a fire or a windstorm, the changes happens more rapidly and frequently (Virkkala 2004). Another effect of the modern management is linked to the fact that it favors conifers, making the composition of tree species in the forests more homogenous. This homogeneity in boreal forest means a lack of specific invertebrates that need deciduous trees for their survival, which in turn means fewer or none of the birds that also need that type of forest. A lot of favorable habitats containing dead wood, deciduous trees and trees of old age are fragmented into smaller isolated stands (Harrison and Bruna 1999). This has a negative effect on birds that demand bigger nesting and foraging areas in this type of forest.

As a part of the Swedish National Environmental Goal called “Living Forests”, (Levande skogar), a number of bird species have been assigned as indicator species. These species are supposed to indicate a number of forest characteristics important for the maintenance of biodiversity. Table 2.1, provides information about these bird species and what they indicate.

Table 2.1. Different indicator species and what they indicate.

High nature values in boreal forest	Dead wood	Deciduous forest and/ or mixed forest, with a lot of deciduous trees	Old forest
Capercaillie	Green Woodpecker	Green Woodpecker	Capercaillie
Hazel Grouse	Lesser spotted Woodpecker	Lesser spotted Woodpecker	Three-toed Woodpecker
Lesser spotted Woodpecker	Three-toed Woodpecker	Three-toed Woodpecker	Siberian Jay
Three-toed Woodpecker	Willow Tit	Marsh Tit	Crested Tit
Green Woodpecker	Marsh Tit	Stock Dove	Siberian Tit
Siberian Jay		Long-tailed Tit	Coal Tit
Nutcracker		Treecreeper	Willow Tit
Crested Tit			Treecreeper
Siberian Tit			Bullfinch
Coal Tit			
Willow Tit			
Marsh Tit			
Stock Dove			
Long-tailed Tit			
Treecreeper			
Bullfinch			

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2.2 Forest management, certification and planning

Today the most of the forest industries and companies in Sweden are certified according to Program for the Endorsement of Forest Certification - also known as the Pan-European Forest Certification (PEFC) and/or the Forest Stewardship Council (FSC) which means they have to consider the environment more in their forest management. Some examples of things that have changed in forest management compared to some decades ago is that more retention wood is left after felling operations, more deciduous trees are left standing and after a final felling there should always be a group of trees left, preferably deciduous trees if possible (Söderström 2008; Lindenmayer and Franklin 2002). There are also restrictions about felling near marshes, swaps, lakes and other areas that are sensitive to erosion and damages that may occur during logging operations.

Forests in Sweden are managed by dividing them into different stands. These are in turn categorized into four different management types with different environmental ambitions and management goals;

Produktion Generell Hänsyn, (PG): Production with general conservation. These stands are managed to produce wood for industry and conservation measures are often set to the lowest level required by the Swedish Forestry Act and FSC/PEFC, which is 10 percent of the stand. (Södra skogsbruksplaner, Fältinstruktion 2011).

Produktion Förstärkt Hänsyn, (PF): Production with enhanced conservation. These stands are managed with both a production goal and a conservation goal. The conservation has to be between 10 – 90 percent of the area of the stand (Södra skogsbruksplaner, Fältinstruktion 2011).

Naturvård Skötsel, (NS): Active nature conservation management. The aim in these stands is to increase their environmental value and enhance biodiversity. This often entails creating more dead wood and thinning conifers to favor deciduous tree which increases the diversity of trees and positively influence many forest species in the landscape. Conservation management may also include cultural heritage objects that exist in the forest and this can also affect the biodiversity. For example an overgrown pasture could be restored for grazing or other uses. In NS – stands the directive is often about creating bright and open stands, which favors deciduous trees. (Södra skogsbruksplaner, Fältinstruktion 2011). Each estate must have a minimum of 5 percent of stands managed as NO or NS to fulfill the requirements of PEFC and FSC.

Naturvård Orörd, (NO): Nature conservation without any active management, which means that nature is allowed to run its own course. These stands contain trees of different age and sizes, dead wood in different successions of decay creating favorable conditions for many different species of cryptograms, phanerogams and birds. (Södra skogsbruksplaner, Fältinstruktion 2011).

Stands that are managed as NS or NO usually contain many more elements favorable for biodiversity as compared to stands that are managed as PG or PF. Therefore, there is presumably a higher abundance and diversity of bird species in those stands with more conservation than the ones more focused on production. This study seeks to test that hypothesis.

3. MATERIAL AND METHODS

3.1 Study area and preparations

The survey took place in Färna Ekopark, located close to Skinnskatteberg in Västmanland, south-central Sweden. The forest is owned by the Swedish state forest company Sveaskog. Before the field work could begin, several preparations had to be made. These concerned the selection of stands and distribution of the survey.

Five forest stands of each management type were selected amounting to 20 stands. These were chosen by using several criteria aiming at finding stands with generally similar size, site conditions and age. The aim was to select stands 3-5 ha large and at least 60 years old or older. Using Sveaskogs database Stefan Toterud identified stands according to these criteria. He also provided maps over the area and shape-files compatible with the computer program ArcGIS. Due to the limited number of stands available to represent different management types, not all the criteria were met in the selection process. The selected stands had the average size of 4.8 hectare (min=0.6, max= 25.3) and the age of the forests ranged between 61 – 133 years. The basic data describing the selected stands is presented in Table 8.1 (Appendix A)

3.2 Bird survey

Birds were counted in stands by point surveys. In each selected stand ArcGIS was used to find three points located not closer to each other than 100 meters (to avoid counting the same individuals more than once) and not closer than 50 meters from the stand's edge. In order to ensure this, buffer zones were created in the stand polygons. Subsequently the function "create random points" in Arc Toolbox was used. However this did not generate the required number of points. Even if points were designated without the buffer zone, there were still frequently only one or two points in many stands.

In order to obtain the most random placement possible, a raster of squares of 100 meters by 100 meters was generated. This was overlaid with the stand polygons in Arc Map, forming a random pattern of squares inside the polygons. Points were then placed at corners of squares. Although the placement inside the polygons was random, a pattern was followed as the points' locations were selected. The first of the three points was chosen by identifying the central most corner in the polygon. When possible, the other two points were placed on corners to the west and north of the original point. If no corner existed in these locations, points were distributed as evenly as possible, maintaining the 100 meter minimum distance between them. The progress of this work is illustrated in Figure 3.1.

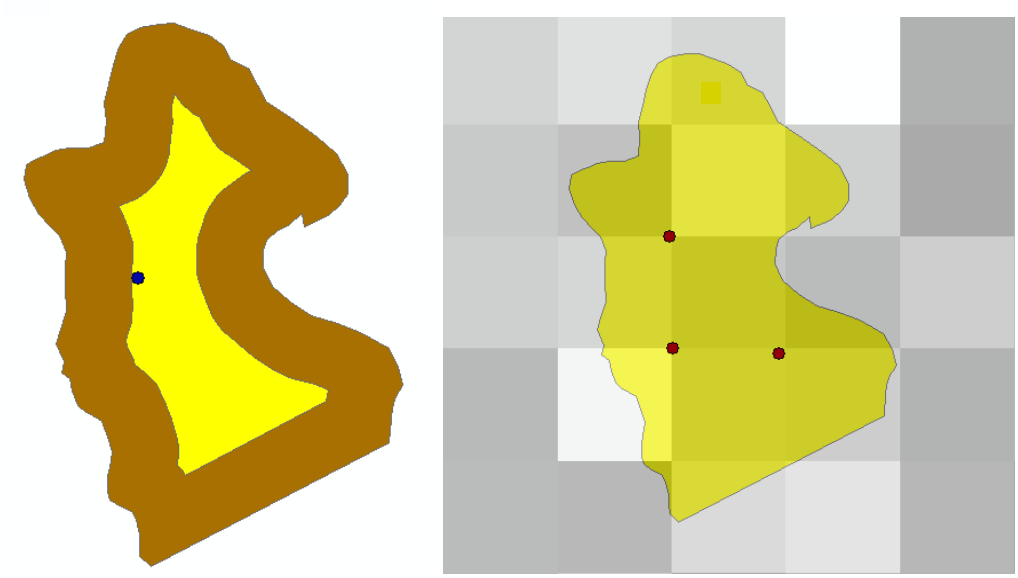

Figure 3.1. *The pictures show the progress in placing points in the stands. To the left, one random point chosen by ArcGIS's "create random point". To the right three points placed after the randomly placed corners.*

The bird survey took place during three spring weeks, one week in March one in April and one in May. These three visits aimed at covering breeding seasons and subsequently periods of increased vocal activity (i.e. enhanced detectability) of both resident birds and migrants. All observations were made between 04:00 to 09:30 am on days without strong wind. The field work was a point survey which means observations were made for five minutes at a specific point. Every bird heard or seen within a 50 meter radius from the point and located within surveyed forest stand was recorded.

3.3 Analyses of data

The data was analyzed in two ways to examine species richness and abundance. First, a one-way ANOVA test was performed at the point level to see if there were any statistically significant differences between the particular management types. Next, the data was analyzed at the stand level for four different categories of birds: Indicator species, cavity-nesters, resident birds and migratory birds. (Table 8.6, Appendix B).

Mean abundance shows the mean of how many individuals were noticed in every management type. For both the ANOVA test and the different categories, only the visit with the highest number of individuals was used for the mean calculations. This was to minimize the risk of counting the same individual twice.

Species richness is a measure of how many different species were detected in each management type. This was assessed by taking a sum of the number of different species (rather than individuals) observed in each stand during the entire survey. These values were then averaged to find the mean for each management type. (Table 8.7 and 8.8, Appendix C).

4. RESULTS

During the survey 478 observation of bird individuals were made, (March =94; April = 202; May = 182). In total, 28 species were observed (25 in NS; 16 in NO; 16 in PF; 17 in PG). There were few species that were exclusive to a particular management types (NS – Starling, *Sturnus vulgaris,* Chiffchaff, *Phylloscopus collybita,* Bullfinch, *Pyrrhula pyrrhula* and Green Sandpiper, *Tringa ochropus* ; NO – Dunnock, *Prunella modularis;* PF – Redwing, *Turdus iliacus).*The most common species was Chaffinch, both in total and in every management type. (Table 8.2; 8.3; 8.4 and 8.5, Appendix B).

4.1. General abundance and species richness of birds in relation to management goals

The species richness and abundance of birds differed significantly among different management types (One-way ANOVA, df = 3, species richness F = 5.62, p = 0.0019 and abundance F = 5.31, p = 0.0027). The average species richness and abundance of birds was highest in points located in NS stands (6.6 and 8.7, respectively), while the lowest in PF (4.06) and PG (5.3). At a 95 % confidence level the difference in abundance was statistically significant between NS and PF. At the same level the difference in species richness was statistically significant between NS and PF, PG. (Fig.4.1 and 4.2).

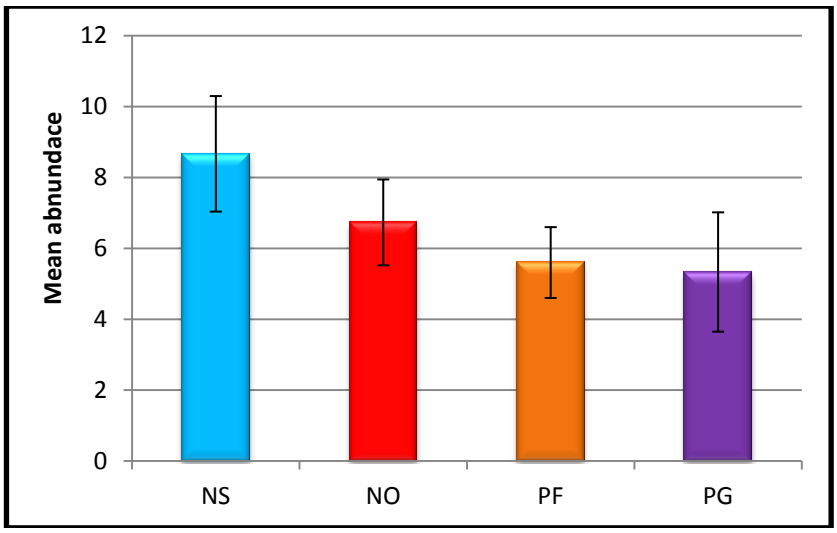

Figure 4.1 *Mean abundance of birds in four different management types.*

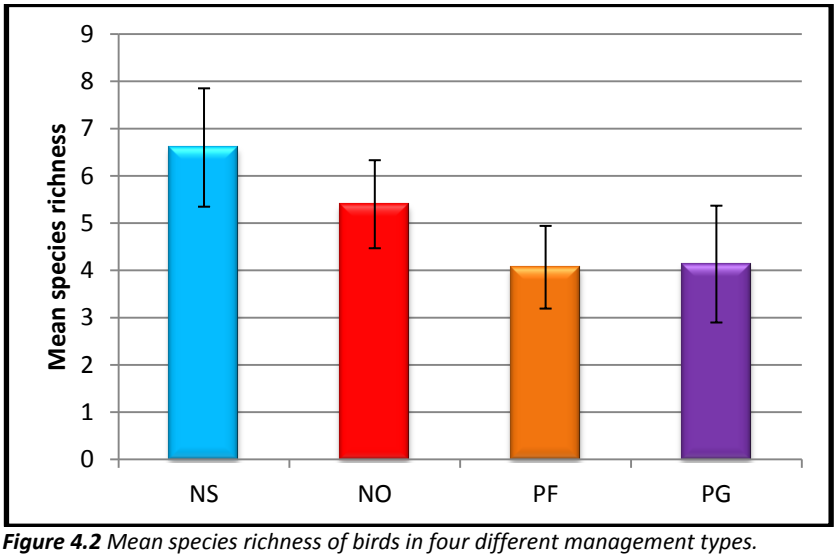

Figure 4.2 *Mean species richness of birds in four different management types.*

4.2 Indicator species; cavity–nesters; resident birds and migratory birds

In figures 4.3 – 4.6 the means of species richness and abundance in management types for four different bird categories are presented. The management types were quite different in terms of species richness and abundance of particular bird groups. However, a substantial variation within particular management type was also observed. The number of indicator species was on average highest in NS (mean=3.2, min=2, max=5) and the lowest in PF (mean=2.0 min=1, max=3), (Fig. 4.3.A). The average abundance of indicator species was higher in NO and NS (mean= 5.0) in comparison to two remaining management types (mean=3.4), (Fig. 4.3.B).

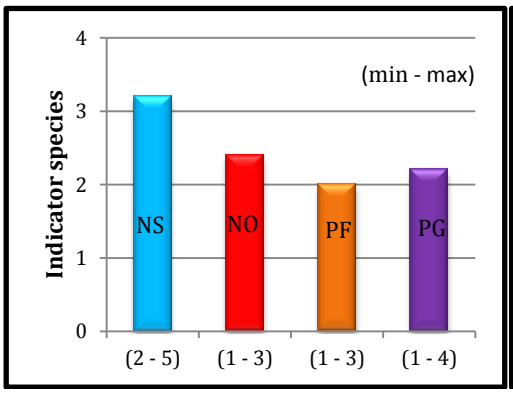

Figure 4.3.A. *The average species richness of indicator species in the different management types.*

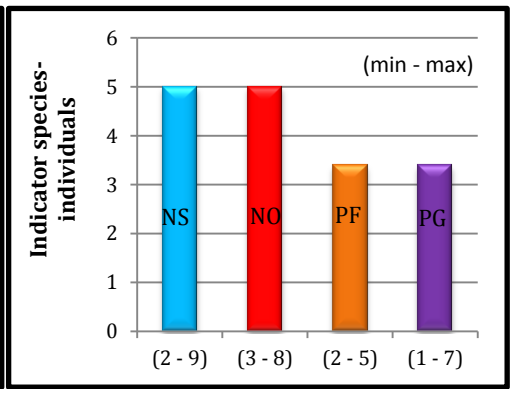

Figure 4.3.B. *The average abundance of indicator species, showing that the level was equally high in NS and NO.*

The number of species classified as cavity-nesters was on average highest in NS (mean=5.6, min=3, max=8) and the lowest in PF (mean=2.6, min=1, max=5), (Fig. 4.4.A). The average abundance of cavity-nesters was highest in NS (mean=11.4, min=6, max=17) and lowest in PF (mean=3.6, min=1, max=7). This was the category that indicated the biggest difference between the management type with the highest value and the one with the lowest. (Fig. 4.4.B).

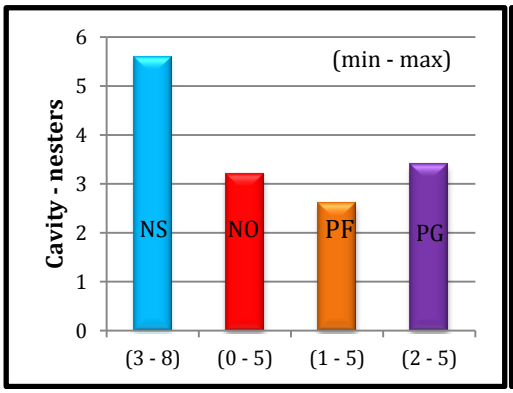

Figure 4.4.A. *The average species richness of cavity – nesters in the different management types.*

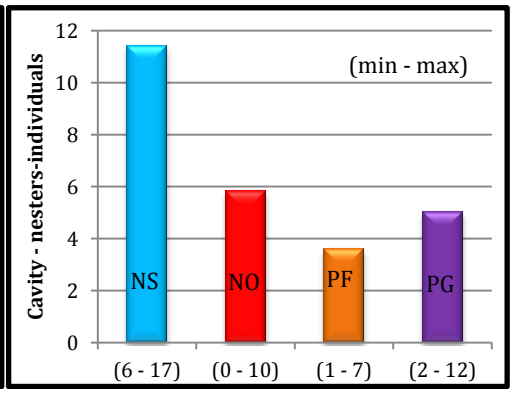

Figure 4.4.B. *The average abundance of cavity – nesters in the different management types.*

The number of resident birds was, as in the categories above, on average highest in NS (mean=7.6, min=5, max=10) and the lowest in PF (mean=4.8, min=2, max=9), (Fig. 4.5.A). Also, the average abundance of resident birds was highest in NS (mean=15.6, min=8, max=20) and lowest in PF (mean=8.2, min=3, max=11). (Fig. 4.5.B).

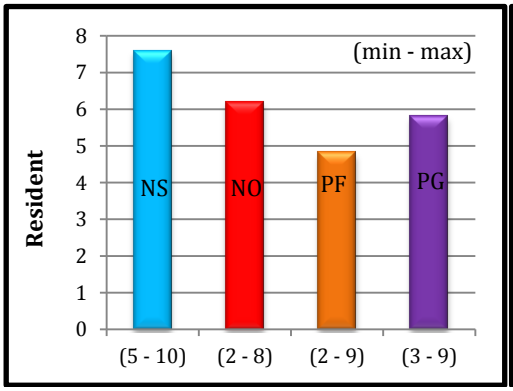

***Figure 4.5.A**. The average species richness of resident birds in the different management types.*

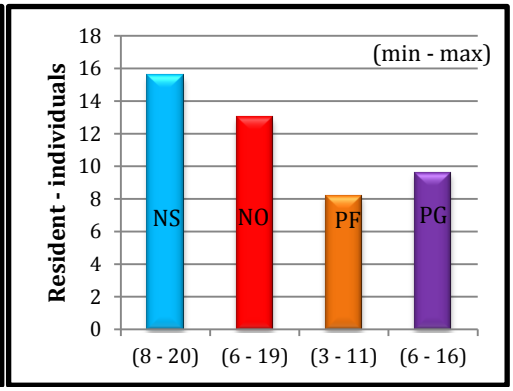

***Figure 4.5.B.** The average abundance of resident birds in the different management types.*

The last category (migratory birds) showed some different results as compared to the pattern the three other bird categories. The number of migratory birds was, on average, highest in NS, (as in the other categories), (mean=4.2, min=3, max=6), but lowest in PG rather than PF (mean=2.2, min=1, max=4), (Fig. 4.6.A). This was also the case looking at the average abundance of migratory birds that was highest in NS (mean=10.4, min=6, max=16) and lowest in PG (mean=6.2, min=3, max=10). (Fig. 4.6.B).

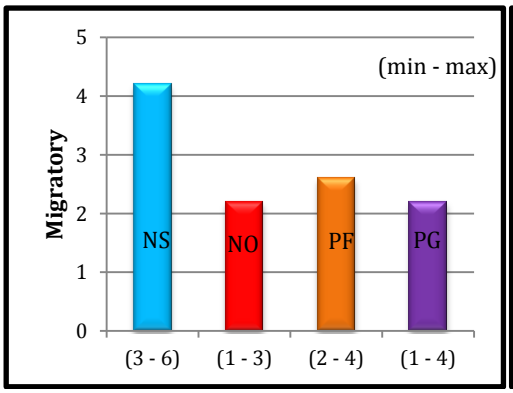

***Figure 4.6.A.** The average species richness of migratory birds in the different management types.*

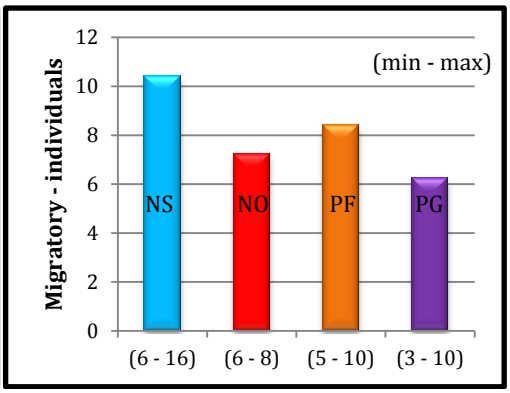

***Figure 4.6.B.** The average abundance of migratory birds in the different management types.*

5. DISCUSSION

5.1 Nature conservation vs. production

The purpose of this study was to determine whether the stands that are managed with a greater degree of conservation, (NS and NO) would have higher bird diversity and bird abundance than the stands managed for production, (PF and PG). The results clearly indicate that this is the case. All analyses show NS stands as having consistently higher abundance and diversity of birds than the other management types. The higher abundance and diversity in NS stands indicates that species find higher variation of species-specific habitat in those stands. This is presumably because they contain more of the favorable structures and qualities mentioned earlier than the other management types such as large deciduous trees and relatively sparse stands with sun exposed trunks. Also, the fact that the dominating tree species in the NS stands was aspen is important since this tree species is favored by woodpeckers because of the invertebrates that may be found, its suitability for the excavation of holes and its importance in providing very diverse and plentiful of invertebrate prey (Angelstam and Mikusinski 1994; Siitonen and Martikainen 1994). A consequence of the woodpeckers nesting and foraging is that a lot of holes are available for other cavity-nesters and process of dead wood creation is enhanced. Not surprising, for the cavity-nesters, (Figure 4.4.A. and 4.4.B.) the NS management type is clearly favored. Figures 4.5.A. and 4.5.B. also show that resident birds favor management type NS most, which makes sense since both the indicator species and cavity-nesters are resident birds as well.

The present study looked exclusively at the bird community. This is certainly one of the important ways to validate the efforts that forestry does to meet environmental objectives. However, it should be noted that that many other groups of organisms may be used as indicators of conservation status of stands and for general assessment of the ecological sustainability of forest management (Gustafsson and Perhans 2010).

5.2 Unexpected results

Management type NO had an abundance and diversity closer to PF and PG than NS which was unexpected. The reason for that is probably that the diversity of tree species found in NO is more like PF and PG. These stands are dominated by conifers and are not as sparse as in NS (Figure 8.1, Appendix A). There is one graph where the values of NO are the same as NS and that is in graph of abundance, indicator species, (Figure 4.3.B). The explanation of that is found in Table 2.1. A lot of the birds that indicate old forest were abundant in NO. Figures 4.6.A. and 4.6.B. show that there were more migratory birds in PF than in both PG and NO. The cause of this result is unclear. Perhaps if the last survey had been performed a couple of weeks later the results of this category might have been in favor of management type NS because during the last survey there were still many species that still had not arrived. This aspect of the timing might be considered when expanding this study in future.

Another unexpected result was that management type PF had the lowest values of abundance and diversity, (except in Figure 4.3.B. where the value was equal to PG and in Figure 4.6.A and 4.6.B). Since these stands are managed with enhanced conservation in some way, it was assumed before the study that PG would be the management type with the lowest counts. Why PF shows a higher abundance and diversity than both PG and NO might be something to examine in another study.

Additionally, it must be stated that the sample size in this study is rather low. Although it big enough for finding statistically significant differences for the entire bird community, the differences between various bird categories must be treated only as indicative due to small sample size and high variation within groups.

5.3 The survey

In this study, birds were used as an indicator for biodiversity in different forest management types. It should be kept in mind that birds are affected by the weather and are not very active when it is too windy or too rainy (Temple and Wiens 1989). This may affect the survey and should be taken in consideration before starting, and when evaluating the results. However, in this study the survey was only performed during acceptable weather conditions. If it was raining or the wind blew stronger than 3 – 4m/s, the survey was cancelled for that day.

Most of the bird species observed were songbirds. The knowledge of birdcalls and songs is therefore crucial in a study like this and in this case also the ability to determine the direction and distance of a bird was very important, particularly in the study designed to compare bird communities at the stand level. The fact that not all species' songs sound equally loud makes these two things challenging. It gets harder the later it is in the spring because more birds arrive and then there are so many songs occurring at the same time that it becomes a cacophony where even the trained ear may find difficult to pick up specific species and individuals. My own skills in recognizing different birds by both song and appearance is generally good and has improved significantly during this year by completing an ornithology class, which proved to be sufficient to perform this study.

As described earlier, the points were placed following a raster in ArcGis to make the placements random. However a consequence of this was that in some stands, none of the points ended up in the center but all of them were close to the stands edge, making it difficult to be sure the birds observed were not birds from the adjacent stands.

5.4 Conclusion

As described in the introduction, the way boreal forests have been managed for some decades has affected birds among other species in a negative way when it comes to diversity and abundance. However, the results from this study show that there is a way to both satisfy the birds and the wood producers – managing more forests as NS stands. It was not the management type NO but NS that was the one with the highest abundance and diversity. This means that it is possible to make a profit out of stands in this management type. However, it may not be as big as the potential profit from a PG stand, but if the market is willing to pay more for deciduous wood, which actually seem to be the case, then maybe more forest owners and companies will be willing to manage NS stands in a larger extent.

6. SUMMARY

This study has compared the biodiversity in four different management types, used in Swedish forestry: PG, PF, NS and NO. The comparison was made through a bird survey, where abundance and diversity of forest birds was analyzed. The survey took place in Färna Ekopark in Västmanland, owned by the Swedish governmental company SveaSkog. The visits were occurred during three different weeks during the spring, one in March, one in April and one in May. After the survey was done the data was analyzed in four different categories, indicator species, cavity-nesters, resident birds, and migratory birds. An ANOVA test was also done to see if there was any statistical significance between the different management types. All the different analyses showed that the management type NS was the one with the highest level of both abundance and diversity. Therefore, one way of improving the diversity and abundance of birds, and presumably others species, in boreal forests might be by managing more stands as NS stands.

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7.2 On – line documents

Link A. http://www.miljomal.se/Miljomalen/Alla-indikatorer/Indikatorsida/?iid=67&pl=1

Link B. www.ne.se

8. APPENDIX

Appendix A.

Table 8.1 Data from all the stands. (* eight-year-old data, ** data missing).

Management type	Nr	Stand	Age	Areal	Site index	Pine %	Spruce %	Birch %	Aspen %	Other deciduous %
NS	1	6628251 -551273	74	3,8	G27	1,2	33,2	6,3	58	1,3
	2	**	130	3,3*	**	1*	1*	20*	69*	9*
	3	6632902 -550819	100	1	G28		5,3	19,9	74,8	
	4	6633601 -549159	73	5,2	G30	21,4	78,6			
	5	6633537 -550826	78	0,6	G28	23,5	9,9	35,8	30,7	
NO	1	6627651 -551900	131	7,2	G22	4,2	83,4	5		7,3
	2	6626617 -554404	108	17,8	T24	53,7	44,5	1,8		
	3	6629796 -550530	108	25,3	T22	61,7	38,3			
	4	6634524 -550763	104	6,4	G26	12,4	75,4	8,4		3,9
	5	6633158 -549283	109	7	G26	3	82,1	10,2		4,6
PF	1	6628401 -553391	76	3	G28	37,7	60,1	2,1		
	2	6628866 -549878	84	6,8	G28	25,6	71,8	2,6		
	3	6632731 -552832	76	3,5	G28	38,9	61,1			
	4	6635343 -549828	79	2,3	G29		100			
	5	6633442 -552200	77	4,5	T23	70,2	29,8			
PG	1	6629406 -548972	61	3,9	T26	37,2	52,2	10,6		
	2	6629188 -553707	76	2,2	T24	90,4	9,6			
	3	6632882 -552625	58	4,9	T25	50,5	38,1	11,4		
	4	6633319 -547241	105	4,8	T22	80,4	19,6			
	5	6634693 -548674	74	6,4	G28	7,2	92,8			

Appendix B

Table 8.2. The number of different species observed during the visits in management type NS.

NS, number of species				
Species: English - Swedish	**March**	**April**	**May**	**Total**
Bullfinch - Domherre	1			**1**
Blue Tit - Blåmes	4	2	3	**9**
Great Tit - Talgoxe	9	5	4	**18**
Crested Tit - Tofsmes	2	1		**3**
Coal Tit - Svartmes	2	5	2	**9**
Long-tailed Tit - Stjärtmes			2	**2**
Marsh Tit - Entita	1	2		**3**
Willow Tit - Talltita		2		**2**
Wren - Gärdsmyg	5	5	4	**14**
Treecreeper - Trädkrypare	3	3	1	**7**
Goldcrest - Kungsfågel	3	4	4	**11**
Brambling - Bergfink	1			**1**
Chaffinch - Bofink		16	12	**28**
Robin - Rödhake		4	6	**10**
Blackbird - Koltrast		2	1	**3**
Song Thrush - Taltrast		1	2	**3**
Starling - Stare		1		**1**
Chiffchaff - Gransångare		1		**1**
Willow Warbler - Lövsångare			11	**11**
Tree Pipit - Trädpiplärka			1	**1**
Green Sandpiper - Skogssnäppa		1		**1**
Nuthatch - Nötväcka	1			**1**
Black Woodp. - Spillkråka	1	1		**2**
Gr. Spotted Woodp. - Större hackspett	4	6	4	**14**
Green Woodp. - Gröngöling	1			**1**

Table 8.3. The number of different species observed during the visits in management type NO.

NO, number of species				
Species: English - Swedish	**March**	**April**	**May**	**Total**
Blue Tit - Blåmes	2	1	1	**4**
Great Tit - Talgoxe	2	4	3	**9**
Crested Tit - Tofsmes	3	2	1	**6**
Coal Tit - Svartmes		2	6	**8**
Marsh Tit - Entita	1			**1**
Siskin - Grönsiska		1	2	**3**
Dunnock - Järnsparv		3		**3**
Wren - Gärdsmyg	1	2	3	**6**
Treecreeper - Trädkrypare	4	10	2	**16**
Goldcrest - Kungsfågel	7	2	5	**14**
Chaffinch - Bofink		21	16	**37**
Robin - Rödhake		6	3	**9**
Blackbird - Koltrast		2	1	**3**
Song Thrush - Taltrast		1		**1**
Willow Warbler - Lövsångare			1	**1**
Gr. Spotted Woodp. - Större hackspett	2	2	1	**5**

Table 8.4. The number of different species observed during the visits in management type PF.

PF, number of species				
Species: English - Swedish	**March**	**April**	**May**	**Total**
Blue Tit - Blåmes	1			**1**
Great Tit - Talgoxe	1	1	4	**6**
Crested Tit - Tofsmes	4	1	2	**7**
Coal Tit - Svartmes		3	2	**5**
Siskin - Grönsiska			2	**2**
Wren - Gärdsmyg		2	1	**3**
Treecreeper - Trädkrypare	1	7	1	**9**
Goldcrest - Kungsfågel	3	1	7	**11**
Chaffinch - Bofink		27	25	**52**
Robin - Rödhake		3	2	**5**
Blackbird - Koltrast		2	2	**4**
Song Thrush - Taltrast		1	1	**2**
Redwing - Rödvingetrast		1		**1**
Willow Warbler - Lövsångare			2	**2**
Nuthatch - Nötväcka			1	**1**
Gr. Spotted Woodp. - Större hackspett		1		**1**

Table 8.5. The number of different species observed during the visits in management type PG.

PG, number of species				
Species: English - Swedish	**March**	**April**	**May**	**Total**
Blue Tit - Blåmes	2			**2**
Great Tit - Talgoxe	4			**4**
Crested Tit - Tofsmes	4	2	2	**8**
Coal Tit - Svartmes	1		2	**3**
Marsh Tit - Entita	1			**1**
Willow Tit - Talltita	2		1	**3**
Siskin - Grönsiska			5	**5**
Wren - Gärdsmyg	3	1		**4**
Treecreeper - Trädkrypare		2	1	**3**
Goldcrest - Kungsfågel	4	2	5	**11**
Chaffinch - Bofink		16	7	**23**
Robin - Rödhake		3	1	**4**
Song Thrush - Taltrast		4		**4**
Willow Warbler - Lövsångare			2	**2**
Nuthatch - Nötväcka			1	**1**
Black Woodp. - Spillkråka			1	**1**
Gr. Spotted Woodp. - Större hackspett	3	1		**4**

Table 8.6 The four different categories and which species that were observed in them.

Indicator species	Cavity-nesters	Resident	Migratory
Green Woodp.	Green Woodp.	Green Woodp.	Tree Pipit
Crested Tit	Black Woodp.	Black Woodp.	Willow Warbler
Coal Tit	Gr. Spotted Woodp.	Gr. Spotted Woodp.	Chiffchaff
Willow Tit	Great Tit	Great Tit	Brambling
Marsh Tit	Blue Tit	Blue Tit	Chaffinch
Long-Tailed Tit	Coal Tit	Coal Tit	Robin
Treecreeper	Crested Tit	Crested Tit	Song Thrush
Bullfinch	Nuthatch	Wren	Redwing
	Willow Tit	Goldcrest	Starling
	Marsh Tit	Nuthatch	Dunnock
	Starling	Bullfinch	Green Sandpiper
		Blackbird	
		Willow Tit	
		Marsh Tit	
		Long-Tailed Tit	
		Treecreeper	
		Siskin	

Link A.*www.miljomal.se,* ***Link B.*** *www.ne.se, Fågelguiden*

Appendix C

Numbers for calculations of mean, for abundance in the four categories.

Table 8.7.A

Indicator species					
Stand	Point	NS	NO	PF	PG
1	1	1	1	0	0
	2	1	3	1	0
	3	0	1	2	3
total/stand		2	5	3	3
2	4	2	1	2	1
	5	1	3	1	0
	6	2	4	0	0
total/stand		5	8	3	1
3	7	3	1	1	5
	8	1	1	1	1
	9	2	1	2	1
total/stand		6	3	4	7
4	10	3	2	2	0
	11	4	1	0	0
	12	2	1	3	2
total/stand		9	4	5	2
5	13	3	2	1	2
	14	0	0	1	0
	15	0	3	0	2
total/stand		3	5	2	4

Table 8.7.B

Cavity-nesters					
Stand	Point	NS	NO	PF	PG
1	1	4	0	2	0
	2	3	1	3	0
	3	5	3	1	3
total/stand		12	4	6	3
2	4	7	2	1	0
	5	7	3	0	1
	6	3	2	0	1
total/stand		17	7	1	2
3	7	7	0	2	5
	8	3	0	2	4
	9	3	0	3	3
total/stand		13	0	7	12
4	10	3	3	1	0
	11	3	2	0	1
	12	3	3	1	1
total/stand		9	8	2	2
5	13	4	2	1	3
	14	2	3	1	1
	15	0	5	0	2
total/stand		6	10	2	6

Table 8.7.C

Resident					
Stand	Point	NS	NO	PF	PG
1	1	5	3	2	2
	2	3	6	5	0
	3	8	4	4	4
total/stand		16	13	11	6
2	4	6	4	4	3
	5	8	4	2	3
	6	3	5	2	4
total/stand		17	13	8	10
3	7	9	2	4	6
	8	4	2	2	5
	9	7	2	3	5
total/stand		20	6	9	16
4	10	5	5	4	0
	11	6	5	2	1
	12	6	4	4	4
total/stand		17	14	10	5
5	13	4	3	1	3
	14	3	7	2	3
	15	1	9	0	5
total/stand		8	19	3	11

Table 8.7.D

Migratory					
Stand	Point	NS	NO	PF	PG
1	1	5	3	3	0
	2	7	2	3	3
	3	4	2	3	0
total/stand		16	7	9	3
2	4	6	2	4	1
	5	3	2	4	2
	6	5	2	2	2
total/stand		14	6	10	5
3	7	5	3	3	3
	8	2	3	4	3
	9	2	1	3	4
total/stand		9	7	10	10
4	10	1	3	2	0
	11	3	3	1	0
	12	2	2	2	4
total/stand		6	8	5	4
5	13	3	2	3	3
	14	1	4	3	2
	15	3	2	2	4
total/stand		7	8	8	9

Numbers for calculations of mean, for species richness in the four categories.

Table 8.8.A

NS						
stand	1	2	3	4	5	Total
Indicator species	2	3	4	5	2	16
Cavity-nesters	5	8	7	5	3	28
Resident	8	8	10	7	5	38
Migratory	6	5	4	3	3	21

Table 8.8.B

NO						
stand	1	2	3	4	5	Total
Indicator species	2	3	1	3	3	12
Cavity-nesters	4	3	0	4	5	16
Resident	8	6	2	7	8	31
Migratory	2	1	3	3	2	11

Table 8.8.C

PF						
stand	1	2	3	4	5	Total
Indicator species	3	2	2	2	1	10
Cavity-nesters	5	1	3	3	1	13
Resident	9	4	4	5	2	24
Migratory	2	3	4	2	2	13

Table 8.8.D

PG						
stand	1	2	3	4	5	Total
Indicator species	2	1	4	2	2	11
Cavity-nesters	2	2	6	2	5	17
Resident	3	6	9	4	7	29
Migratory	3	2	4	1	1	11