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Jämförelse mellan fågelsamhällen i bestånd av introducerad contortatall och inhemsk tall i Sverige

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Keywords: Boreal forest, *Pinus contorta*, *Pinus sylvestris*, bird assemblage, *Muscicapa striata*

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Abstract

The introduced lodgepole pine (*Pinus contorta*) occupies more than 650 000 hectares in Sweden. There are some differences between lodgepole pine and Scots pine (*Pinus sylvestris*) forests which could affect bird assemblages, for example differences in canopy density and ground vegetation. Birds were surveyed in 14 localities in northern Sweden, each characterized by one middle-aged stand of lodgepole pine next to a stand of Scots pine. The two paired stands in each locality were planted by the forestry company SCA at the same time and in similar environment to evaluate the potential of lodgepole pine in Sweden. In those 14 localities, one to three point count stations were established in both the lodgepole pine and the Scots pine stand, depending on the size of the area. The point count stations had a radius of 50 meters and all birds seen or heard inside that radius (overflying birds excluded) were counted on four visits in late May and June. There were no significant differences in total abundance and species richness between the lodgepole pine and Scots pine stands. A total number of 20 species were counted in Scots pine and 19 species in lodgepole pine. The spotted flycatcher (*Muscicapa striata*) had a significantly higher abundance in lodgepole pine stands and the chaffinch (*Fringilla coelebs*) had a nearly significantly higher abundance in the lodgepole pine stands. Two species had a tendency to be more common in the Scots pine forest: the goldcrest (*Regulus regulus*) and the willow warbler (*Phylloscopus trochilus*), but the differences were not statistically significant. I conclude that the common species which were recorded in large enough numbers for statistical analyses are probably not negatively affected by lodgepole pine at the stand scale, but further studies would be required to assess the breeding success of sensitive resident birds in lodgepole pine habitats before any definite conclusions can be drawn.

Sammanfattning

På 1920-talet införde man contortatallen (*Pinus contorta*) i Sverige och arealen med contorta har kraftigt ökat under 70- och 80-talet och uppgår nu till 650 000 hektar. Det finns vissa strukturella skillnader mellan en contortaplantering och en tallplantering (*Pinus sylvestris*). Bland annat är krontaket mycket tätare och sluter sig tidigare i en contortaplantering. Den skapar även en upp till tre gånger så hög mängd barr på marken vilket påverkar markvegetationen. Dessa egenskaper gör bland annat att andelen gran (*Picea abies*) och lövinslag i contortaplantagen är mycket lägre och även insektsfloran lär skilja något vilket gör att mängden föda för flera fågelarter kan påverkas. Fågelinventeringen gjordes i 14 odlingsförsök planterade av skogsbolaget SCA under åren 1969-70. Lokalerna var placerade i norra Sveriges inland och contorta- och tallbestånden planterades jämsides varandra och var mellan 10 till 45 hektar stora. Beroende på beståndets storlek lades en till tre fågeltaxeringsytor ut vilka hade en radie på 50 meter. Inom dessa ytor inventerades under 10 minuter per besök alla fåglar som sågs eller hördes (överflygande fåglar räknades ej). De 14 lokalerna besöktes 4 gånger. Resultaten visade inte på några stora skillnader i total abundans och inte heller i artrikedom mellan de båda beståndstyperna. I tallplanteringarna registrerades totalt 20 arter och 19 i contortaplanteringarna. Den enda fågelart som hade en signifikant högre abundans till contortabeståndens fördel var grå flugsnapparen (*Muscicapa striata*). Även bofinken (*Fringilla coelebs*) hade en nästan signifikant högre abundans i contortabestånden. Kungsfågeln (*Regulus regulus*) och lövsångaren (*Phylloscopus trochilus*) hade en tendens till att vara vanligare i tallbestånden. Sammanfattningsvis är de vanligt förekommande arterna som påträffades i tillräckligt stora antal i den här studien troligtvis inte negativt påverkade av contortatallen i Sverige. Däremot krävs vidare studier som fastställer häckningsframgång, för att utvärdera hur dessa påverkas när contortatallen planteras i stor omfattning, särskilt för de stannfåglar som kan vara känsligare för habitatförändringar än flyttfåglar.

Introduction

The lodgepole pine

Back in the 1920 the North American lodgepole pine (*Pinus contorta*) was introduced for the first time in Sweden and today there are about 650 000 hectares which consist of at least 5 percent of lodgepole pine in Sweden. Approximately 475 000 hectares consist of more than 65 percent lodgepole pine and the present distribution of lodgepole pine is shown in figure 1(Cory 2010). Most of the areas have been planted after 1970 (Engelmark 2011). In comparison to the native Scots pine (*Pinus sylvestris*), the lodgepole pine has a superior growth rate and a wood production that is more than 30 percent higher compared to the Scots pine (Norgren 1995). One of the causes of this superior growth is that the lodgepole pine has a root system with thinner roots that quickly penetrates the soil and extracts big amounts of water and nutrients to the tree. The lodgepole pine also has a greater proportion of its biomass in needles compared to the Scots pine. This kind of growth strategy also makes the lodgepole pine more sensitive to damage by wind and snow (Norgren 1995).

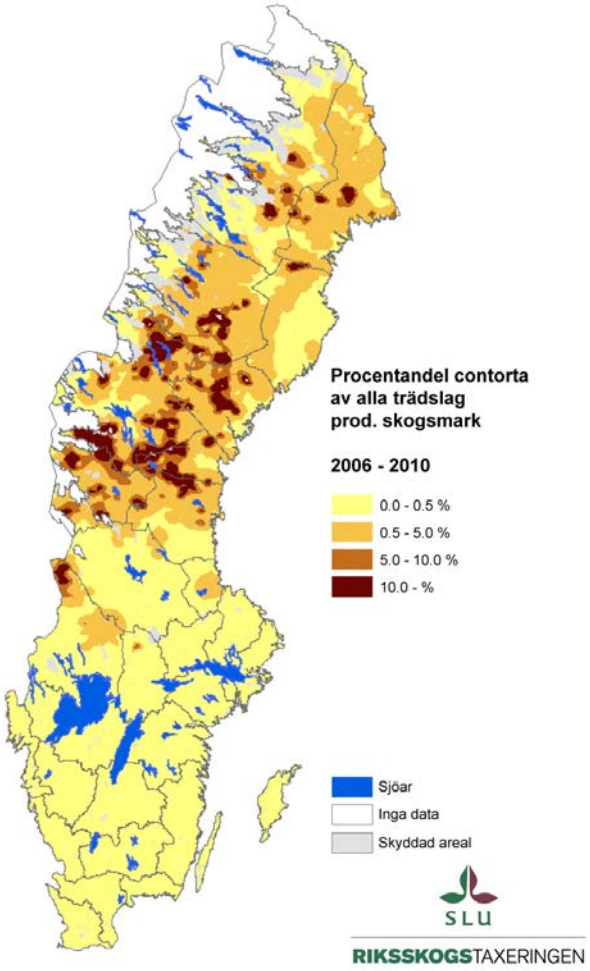

Figure 1: Distribution of lodgepole pine in productive forest areas in Sweden, years 2006 to 2010. (Riksskogstaxeringen 2012-10-03)

When a new species is introduced it influences the ecosystem and the native species in the environment (Engelmark 2011). A lodgepole pine stand grows faster and creates an earlier and denser canopy which shadows and affects the ground vegetation differently than a Scots pine stand, which in turn could affect the abundance of invertebrates. According to Nilsson (2008) a typical lodgepole pine stand has a three times higher amount of needles on the ground compared to a Scots pine area. This will affect the humus and the soil chemistry. The denser canopy in a lodgepole pine forest disfavors shade intolerant species and the ground vegetation in those areas will be less diversified. According to Roberge and Stenbacka (in prep. 2012) there are more tree species, such as Norway spruce (*Picea abies*) and birches (*Betula pubescens* and *B. pendula*) in middle-aged Scots pine forest than in comparable lodgepole pine forest.

Birds and lodgepole pine

Birds are selecting habitats for many reasons. One of the reasons is food availability (Sjöberg 2000). For example, species that consume conifer seeds could have problem with the different sized and darker colored lodgepole pine seeds. Also, the fact that the cones are largely serotinous could affect the species that are adapted to other conifers cones e.g. the parrot crossbill (*Loxia pytyopsittacus*) (Svensson 1999). Another characteristic of the lodgepole pine stands is the denser canopy which could work as more protection from predators, e.g the sparrowhawk *(Accipiter nisus*). The denser canopy could also elaborate additional possibilities for building nests which may influence the bird diversity. The less diversified ground vegetation could decrease the number of niches. The understory vegetation with deciduous trees and larger bushes, which work as a food source or shelter, could be more uncommon in a lodgepole pine area. In a study by Sjöberg et al (1993) the breeding success of the pied flycatcher (*Ficedula hypoleuca*) was studied in lodgepole and Scots pine habitats. The clutch size in the Scots pine habitat was higher than in the lodgepole pine, which indicates a better habitat quality. The study by Sjöberg et al (1993) did not show any significant differences in numbers of breeding pairs which could be explained by between-site variation such as planting techniques, occurrence of wet patches, light condition and so on.

Objectives of the study

The objective of this study was to determine if there are differences in the bird assemblages in Scots pine and lodgepole pine stands. I hypothesized that the diversity and abundance of birds would be lesser in the lodgepole pine compared to the Scots pine stands because birds would probably be less adapted to this new habitat which they did not evolve within. The Scots pine stands, having more of other tree species, would also be characterized by more layers and would therefore offer more niches than the lodgepole pine stands, resulting in higher bird species richness.

Materials and methods

Back in 1970, the forest company SCA planted lodgepole pine and Scots pine stands in northern Sweden to evaluate the performance of lodgepole pine for wood production in Sweden. Fifteen of those localities were used in this study, but one had been felled prior to this study, so only 14 were used (see Figure 2). The localities was 10 to 45 hectare and located in the inner part of northen Sweden. In each locality, two stands were planted side by side: one with lodgepole pine and the other with Scots pine. The basal area for the lodgepole pine stands was 25.5 m^2/ha and in Scots pine 22.6 m^2/ha, spruce and birch had higher basal area in Scots pine stands (Roberge and Stenbacka, in prep. 2012).

Figure 2: The 15 study stands of which 14 were surveyed (the one with a cross over had been felled).

Depending of the size of the stand, one to three point count stations with a radius of 50 m were selected. The selection of the point count stations was done without any prior knowledge of within-stand characteristics . The point count stations were located according to the following rules: The center of the point must be at least 100 m away from the edge of the stand and at least 150 m away from any other point count station (to minimize the risk of counting the same individual twice). In locality 6, the Scots pine area was too small to allow a distance ≥100 m to the edge of the stand. Hence in that stand the minimum distance was 75 m. Special care was taken so that no objects visible on map (e.g. water, power line, experimental plots, wet/waste land or a road) intercepted the point count radii. The stand with the fewest point count stations set the number of stations for both stands in each pair of Scots pine and lodgepole pine. For example if one stand in a pair could fit three point count stations and the other only two, only two stations were established in each of the stands. A total of 50 point counts stations were surveyed across all study localities, half of them in lodgepole pine stands and half in Scots pine stands.

The point count survey method (Bibby et al 2000) is a well-established method for surveying birds. All birds observed within a radius of 50 meters were counted, but birds that flew over the area without landing were excluded. A laser range finder was used to calibrate the 50 m distance estimate at each point count station and each visit to a point count lasted exactly 10. The monitoring started roughly two minutes after arrival to the spot and this was done to let birds distracted by my arrival start singing again. If there were nestlings or younger birds within the radius, they were counted as only one individual and if they were accompanied by an adult, only the adult was counted.

To find the way to the localities, a hand held Global Positioning System (GPS) was used. After the first visit the coordinates at every point count station were saved as a waypoint on the GPS so it would be easy to get to the exact same point on consecutive visits.

A total of four visits at every point count station were made between 22 of May and 30 of June 2012, and for the first visit the survey at a given locality always started with the lodgepole pine stand. When all stands had been visited once the second round of visits started. The localities were visited in roughly the same order at every one of the four visits. For the second visit every survey at a given locality started with Scots pine and like the first time every study stand had to be surveyed before the third visit could start. For the third visit the order was alternated so if the survey at a given locality started with lodgepole pine, the next started with Scotch pine. The original plan was to do three visits, but because of good weather and quick surveying there was time for a fourth visit so for that the last visit, the areas were alternated in a way opposite to the third visit.

Birds are more active in early morning (Elzinga, 2001) so the time for monitoring was between 03:00 and 11:00. The logistics were planned in such a way that, after the four visits, every area had been surveyed twice before 08:00 and at maximum only once after 10:00. No surveys were performed during heavy rain or strong wind.

The vegetation had already been surveyed during a study in the summer 2010 (Roberge and Stenbacka, in prep. 2012) so for the vegetation, the only variable that was measured in this study was if the greatest part of the area had been thinned and the number of trees that had recently fallen or broken over breast height. If part of the tree or top of tree was inside a radius of 20 meters around the center of the point count station, it was counted. This counting was made on the first visit. To separate fresh from old fallen trees, the only criterion was that the fresh trees had green needles or leaves. Only trees (both deciduous and conifers) with at least 10 cm in diameter breast height were counted. Five of the 14 localities were severely damaged by wind, probably when the storm Dagmar stoke in Sweden in 26 of December 2011 (wiki 2012-10-03). Both Scots pine and lodgepole pine stands were affected in these localities, but the lodgepole pine stands were more severely affected by the storm.

Data analysis

The observations were entered into the program Open Office Calc and every species' highest abundance at each point count station across all four visits was calculated. For example if a given species was encountered with the abundances 2, 1, 3 and 1 individuals on the four visits, respectively, at a given point count station, the highest abundance was 3. Then, for each stand, the mean of the abundance values was calculated across the different point count stations. For example, if one lodgepole pine stand had 3 point count stations with the highest abundances 0, 2 and 3, the mean abundance for this stand was 1.67 birds per point count station. The R statistical package (r-project 2012) was used for the statistical analyses. The analyses were performed for all of the 14 localities and also separately for the 9 localities which had not suffered much wind damage. The criterion for a wind damaged stand was ≥ 4 fallen trees on average per point count station in lodgepole pine, which in the Scots pine stands matches ≥ 1.33 trees. The stands that were not wind damaged had ≤ 2 fallen trees in lodgepole pine and ≤ 0.5 in Scots pine stands. The statistical test used was Wilcoxon's signed rank test which is a nonparametric test for comparing medians in two groups of paired samples (here paired stands of Scots and

lodgepole pine) (Elzinga 2001). I used a nonparametric test because the data were not normally distributed. The total of all species highest abundances in lodgepole pine versus Scots pine areas were compared using Wilcoxon's signed rank test.

Results

A total of 19 species were observed in the lodgepole pine stands compared to 20 species in Scots pine stands (Appendix 1). The number of species detected per forest stand over all point count stations and all visits was not significantly different between the lodgepole pine and Scots pine stands. In lodgepole pine stands there was a mean number of 5.5 species (median = 5) and in Scots pine stands 5.8 species (median = 5) (p = 0.75) (fig. 3).

Regarding the species level analysis (fig. 4), only the spotted flycatcher (*Muscicapa striata*) was significantly more abundant in lodgepole pine stands with a mean abundance of 0.7 (median = 0.5) compared to 0.3 (median = 0) in Scots pine stands (p = 0.027). The chaffinch (*Fringilla coelebs*) was nearly significantly more abundant in the lodgepole pine stands with a mean value at 1.3 (median = 1.3) compared to 1.1 (median = 1) in Scots pine stands (p = 0.094). Some species had a tendency to be more abundant in the Scots pine stands. The goldcrest (*Regulus regulus*) had a mean value of 0.6 (median = 0.5) in Scots pine stands and a mean value of 0.25 (median = 0) in lodgepole pine stands (p = 0.14). The willow warbler (*Phylloscopus trochilus*) had a mean value of 0.5 (median = 0.5) in Scots pine stands and a mean value of 0.3 (median = 0) in lodgepole pine stands (p = 0.17).

When the five wind damaged stands were excluded, the spotted flycatcher and the willow warbler got the same nearly significant p-value (p = 0.063). For those nine stands the spotted flycatcher got an average abundance of 0.6 (median = 0.5) in lodgepole pine stands and 0.1 (median =0) in Scots pine. The average abundances for Willow Warbler were 0.1 (median =0) in lodgepole pine stands and 1.1 (median = 0.5) in Scots pine.

When comparing the total abundance of all species (fig. 3) there was no significant difference. The mean abundance in lodgepole pine stands was 5.1 (median=4.3) and the abundance in Scots pine stands was 5.0 (median=4.5) (p=0.98).

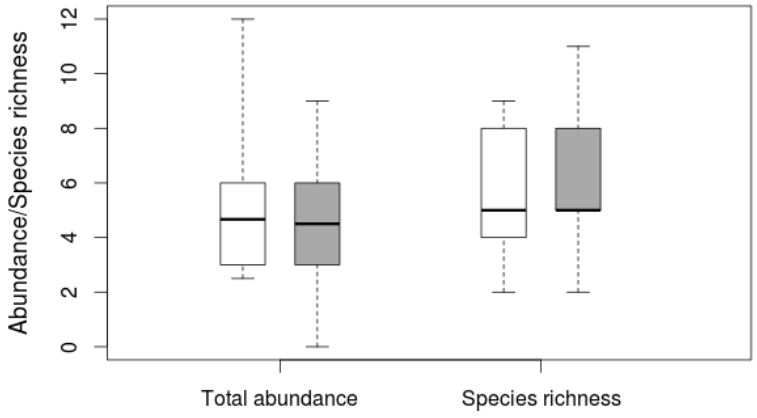

Figure 3: Distribution of the mean total abundance per point count station for 14 stands of lodgepole pine and for 14 paired stands of Scots pine. Species richness shows the number of observed species per study stand. White bars depict Lodgepole pine stands and grey bars Scots pine stands. The whiskers show the highest and lowest values. The bars show the 75% and 25% quartiles and the median value is marked by the black stripe.

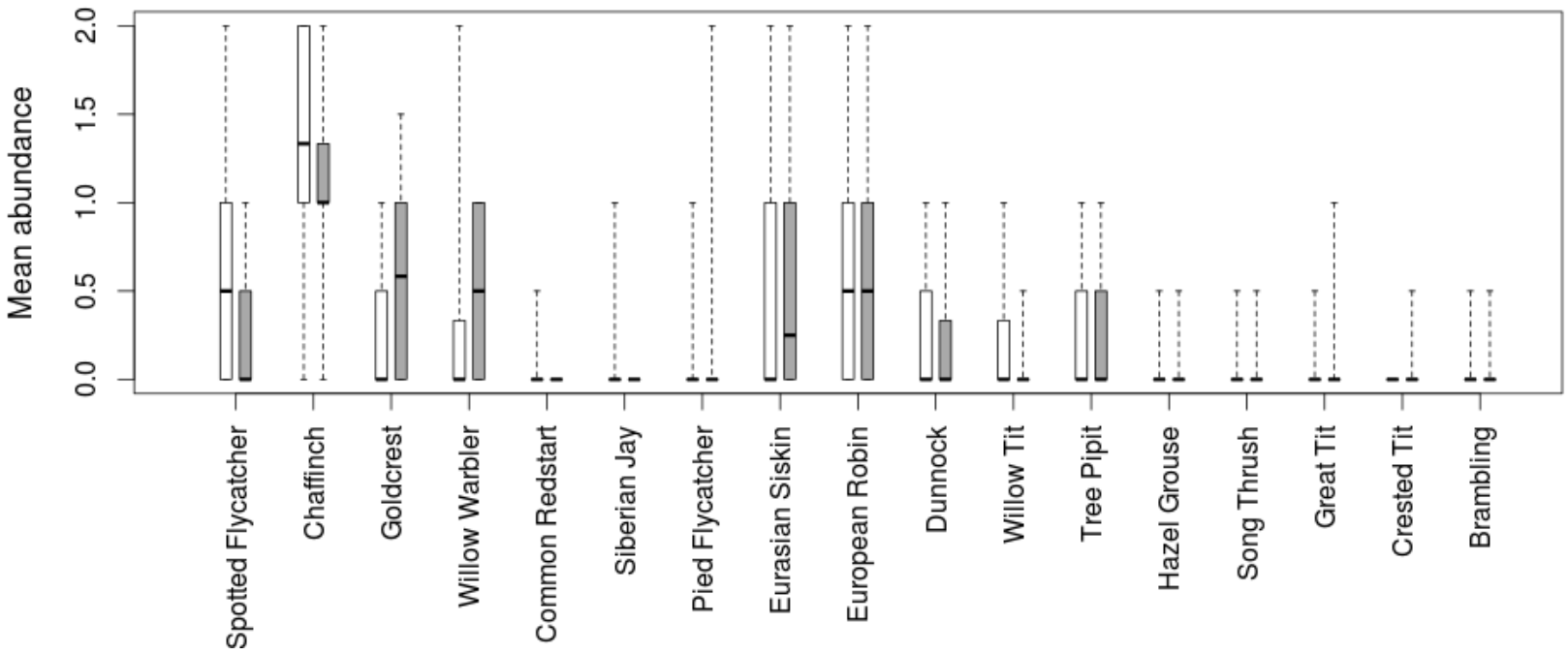

Figure 4: Mean abundance per point count station for the 14 pairwise study stands for each species (except those that were only observed once; Appendix 1). White bars depict lodgepole pine stands and grey bars Scots pine stands. The whiskers show the highest and lowest values. The bars show the 75% and 25% quartiles and the median value is marked by the black stripe.

Discussion

The bird species richness for lodgepole pine and Scots pine stands was very similar in this study. When comparing the total species richness of birds the Scots pine got 20 species and the lodgepole pine got 19 species. The sum of the abundances of individuals across the different species did not differ either between the two forest types. This striking similarity in bird assemblages between the two forest types could mean that the common species in the boreal Scots pine areas have generalized requirements and hence have small or no problem with making use of the new lodgepole pine habitat. Maybe the species that are more uncommon in this study and those kinds of forests could differ further and be of more interest than the common ones. Those species which were recorded only once or a few times could be of more interest in a later study.

Even more interesting would be to study resident birds which could be more sensitive if large areas of their natural habitat transforms into lodgepole pine habitats due to their greater vulnerability to changes in forest environments (Imbeau et al 2001). The problem is that resident birds have an earlier breeding season, which causes difficulties with the field work due to impracticable roads (snow cover and the soil thawing). Even on the 22nd of May, when this study begun, some of the roads were hardly trafficable.

The spotted flycatcher, which had higher abundance in lodgepole pine stands, avoids densely forested areas and prefers more open habitats with some few larger trees to perch and with open spaces for catching flying insects (Cramp et al 1993). The lodgepole pine stands with both their higher trees (faster growing and also bigger at 40 years age) and more wind damaged areas (more open habitats in the wind damaged areas) could favor this species. When the wind damaged stands was excluded, the spotted flycatcher still showed a trend toward higher abundance in lodgepole pine stands. Maybe the p-value when including the wind damaged stands is relatively lower than the p-value in the 9 non-windblown stands because of the much larger amount of data, from 9 to 14 localities, which results in higher statistical power. It thus seems that the spotted flycatcher prefers the denser and higher lodgepole pine stands rather than the Scots pine stands. A lot of lodgepole pine stands had more curvy and damaged trees and a lot of broken stems, probably because of snow breakage. This could, for the spotted flycatcher, create additional suitable places for nests, compared to a Scots pine stand.

The chaffinch was the most common bird in both of the habitats and it had a nearly significantly higher abundance in lodgepole pine than in the Scots pine stands. The chaffinch is a very common bird in all kinds of forests in Sweden. The highest abundances are found in deciduous forests but they are quite common in all kinds of forests (Svensson et al 1999). Indeed this is a forest generalist that does not have specialized habitat requirements. The abundances for all species in the both lodgepole pine and Scots pine stands did not differ that much so maybe the chaffinch prefers the lodgepole pine because of lower competition from other birds. According to (Cramp et al 1994) the brambling is the species that replaces the chaffinch further north but in this study there were only two bramblings recorded so if it is competition it has to be with some other bird species.

The goldcrest and the willow warbler both showed tendencies towards a higher abundance in the Scots pine forest. According to Svensson et al (1999) the goldcrest almost always builds its nest in

the branches of a spruce and prefers spruce dominated stands with some deciduous trees. According to Roberge and Stenbacka (in prep. 2012) there were more spruces in the Scots pine stands than in the lodgepole pine stands. The lodgepole pine stands do contain spruces and deciduous trees so the goldcrest has possibilities to exist also in this habitat.

According to Felton et al (2011) the willow warbler prefers forests with deciduous trees and the amount of deciduous trees are higher in the Scots pine stands (Roberge and Stenbacka in prep 2012) which may explain the willow warbler's abundances in those two different habitats.

The lodgepole pine is more sensitive to wind damage (Norgren 1995), so it can be argued that stands with a lot of windblown and snow-broken trees should be included in such a study, as this phenomenon actually reflects reality of lodgepole-pine based forestry. If the lodgepole pine is planted in smaller stands and in wind protected areas in the landscape, the areas with fallen trees would probably be smaller. When excluding the five stands with a lot of fallen trees, most of the species got higher p-values and this was probably because of the lower statistical power. However, the willow warbler actually had lower p-values after the exclusion of those five stands. Maybe the canopy in the standing lodgepole pine forest was too dense to be favored by the willow warbler, which according to Cramp et al (1992) actually prefers more open habitats.

Limitations of the study

The survey method could frighten some birds from the point count station such as thrushes, doves, woodpeckers and grouses. Fifty meters is not a long distance so most of the birds inside the counting radius probably are aware of your presence. But this would not make any difference between those two habitats, if anything, it would probably only make the difference more or less obvious. The numbers of birds which were recorded in this study should therefore only be considered a relative index and not an absolute estimate of the number of birds in the stands. Sometimes the birds could give away warning calls and bring other birds' attention to the area. So when there is an area with many birds inside the possibilities for some of them to react on your presence and attract other birds is higher. Often when the thrushes were detected at a point count station they yelled out warnings, maybe they had a nest near to the area and their warnings did often attract other birds. This happened approximately as often in both areas so in this study it would probably make no major difference.

The stands were all planted in 1969-1970 and thus all of the studied stands are about 40 year old. To obtain a general assessment of the total impact of lodgepole pine on bird assemblages in Sweden, similar studied should be performed in younger and older forests to see how much the lodgepole pine influences the characteristics of bird assemblages over an entire forestry rotation.

It should be kept in mind that the low bird densities in the studied forest stands mean that the overall statistical power at the species level was limited in this study. Moreover, one important detail is that this study only addresses bird abundance and not breeding habitat quality. According to Van Horne (1983) it could be misleading to use abundances and directly translate these into what an area could maintain in the long term. Bock and Jones (2004) do actually argue that abundance usually is a good indicator of both habitat quality and reproductive success.

Conclusions

I conclude that the common species recorded in this study are probably not negatively affected by lodgepole pine at the stand scale, at least not in middle-aged stands. Nevertheless, further studies are required to assess the breeding success of birds in lodgepole pine habitat. In particular, more knowledge is required about the effects on rarer species and especially sensitive groups such as resident birds before final conclusions about the impact of lodgepole pine on Swedish breeding birds can be drawn.

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Pictures:

Figur 1: Riksskogstaxeringen. http://www.slu.se/sv/webbtjanster-miljoanalys/statistik-om-skog/virkesforrad/virkesforrad-kartor/

Figur 2: Roberge and Stenbacka in prep. 2012

Appendix 1

Scientific name	**English name**	**Swedish name**	**Wilcoxon's signed rank test (n=14+14)**	**Total abundance *P. contorta***	**Total abundance *P. sylvestris***
Anthus trivialis	Tree pipit	Trädpiplärka	V=7, p=1	10	8
Carduelis spinus	Eurasian siskin	Grönsiska	V=15, p=0.711	12	25
Columa palumbus	Common Wood Pigeon	Ringduva	NA[a]	1	0
Erithacus rubecula	European Robin	Rödhake	V=19, p=0.723	20	26
Ficedula hypoleuca	Pied Flycatcher	Svartvit Flugsnappare	V=3, p=0.625	6	13
Fringilla coelebs	Common Chaffinch	Bofink	V=19, p=0.0938	69	54
Fringilla montifringilla	Brambling	Bergfink	NA	1	1
Muscicapa striata	Spotted Flycatcher	Grå Flugsnappare	V=41, p=0.0273	22	7
Parus cristatus	Crested Tit	Tofsmes	V=0, p=1	0	2
Parus major	Great Tit	Talgoxe	V=0, p =1	1	2
Perisoreus infaustus	Siberian Jay	Lavskrika	V=6, p =0.250	5	0
Phoenicurus phoenicurus	Common Redstart	Rödstjärt	V=6, p=0.250	3	0
Phylloscopus collybita	Common Chiffchaff	Gransångare	NA	0	1
Phylloscopus sibilatrix	Wood Warbler	Grönsångare	NA	1	0
Phylloscopus trochilus	Willow Warbler	Lövsångare	V=10.5, p=0.172	9	19
Picoides tridactylus	Three-toed Woodpecker	Tretåig Hackspett	NA	0	1
Poecile montanus	Willow Tit	Talltita	V=4.5, p=0.750	4	5
Prunella modularis	Dunnock	Järnsparv	V=21, p=0.742	9	5
Pyrhulla pyrhulla	Bullfinch	Domherre	NA	0	1
Regulus regulus	Goldcrest	Kungsfågel	V=19.9, p=0.141	5	23
Sylvia curruca	Lesser Whitethroat	Ärtsångare	NA	1	0
Tetrastes bonasia	Hazel grouse	Järpe	V=4, p=1	3	1
Turdus iliacus	Redwing	Rödvingetrast	NA	0	1
Turdus philomelos	Song Thrush	Taltrast	V=2, p=1	2	2
Turdus viscivorus	Mistle Thrush	Dubbeltrast	NA	0	1

[a] Not enough data to perform the test

SENASTE UTGIVNA NUMMER

2011:5 Grey-sided vole and bank vole abundance in old-growth forest patches of different size and connectivity.
Författare: Niklas Paulsson

2011:6 *De novo* sequencing and SNP discovery in the Scandinavian brown bear (*Ursus arctos*).
Författare: Anita J Norman

2011:7 A genetic approach to identify raccoon dog within a large native meso-carnivore community.
Författare: Dan Wang

2011:8 Is old forest like old forest? Patterns in abundance and species number of resident birds in old boreal forest stands in relation to stand structure and landscape context.
Författare: Ortrud Leibinger

2011:9 Klövviltets nyttjande av foderraps på viltåker och betespåverkan på angränsande skog.
Författare: Maria Lidberg

2012:1 Attityder till återintroduktion av visent i Sverige.
Författare: Axel Bergsten

2012:2 Viltanpassad röjning längs skogsbilvägar som en foderskapande åtgärd för älgen.
Författare: Ida Forslund

2012:3 Spawning site selection of brown trout in habitat restored streams.
Författare: Jonas Svensson

2012:4 The shift in forest and tree limits in Troms County – with a main focus on temperature and herbivores.
Författare: Kristoffer Normark

2012:5 Clover (*Trifolium* spp) gamefields: Forage product ion, utilization by ungulates and browsing on adjacent forest.
Författare: Karl Komstedt

2012:6 Habitat use and ranging behaviour of GPS tracked juvenile golden eagles *(Aquila chrysaetos).*
Författare: Carolin Sandgren

2012:7 Spatial and temporal variation in the quality of summer foods for herbivores along a latitudinal gradient.
Författare: Michaela Holá

2012:8 Hur livshistoriekaraktärer hos Europeisk abborre (*Perca fluviatilis* L.) påverkas av cykliska förändringar i populationsstrukturen.
Författare: Christian Andersson

2012:9 Neighborhood effects as a plant defence against ungulate herbivory.
Författare: Bregje Koster

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