# A sneak peek on the upcoming results of the comparison studies regarding the declining Lesser Spotted Woodpecker (*Dendrocopos minor*) in Scania, Sweden

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## Abstract

In recent years the populations of the lesser spotted woodpecker (*Dendrocopos minor*) has been declining in Sweden. Many other species, like for example the marsh tit (*Poecile palustris*), depend on woodland structures that the lesser spotted woodpecker creates such as nesting holes. I did a comparison study between data from The Lesser Spotted Woodpecker Project made in 1980's and my own recently collected data. With this information the following three questions regarding the lesser spotted woodpecker: i) Is there any change in suitable habitat area? ii) Has the presence of lesser spotted woodpecker changed since the last inventory? iii) What has changed regarding the forest composition in the squares where the lesser spotted woodpecker does not occur anymore? In addition to these questions I will also answer the following two questions regarding the marsh tit: iv) Does the marsh tit occur in the same areas as the lesser spotted woodpeckers? v) Does the size of the connected suitable habitat area differ whether the marsh tit is present or not? Mainly the same field work was performed as in The Lesser Spotted Woodpecker Project (1985). By taking a closer look at the localities where the lesser spotted woodpecker today is absent some changes in woodland structures could be detected such as a decline in old forests and area of suitable habitat. To be able to help the lesser spotted woodpecker to regain their viability conservational work should focus on preserving old forests with dead trees and forest management should make sure that today and future forests contain a full range of growth stages. By protecting the lesser spotted woodpeckers habitat both they and other species such as the marsh tit will benefit.

## Introduction

You do not need to consider yourself to be an ornithologist to appreciate the sound of bird singing while having a stroll in a beautiful, dense summer forest. Bird activity in deciduous forests declines during autumn and winter season since many species migrate to warmer latitudes. But some species decide to stay and in Europe the Lesser Spotted Woodpecker (*Dendrocopos minor*) is present all year around. The lesser spotted woodpeckers are the smallest woodpeckers in Europe (Svensson and Grant, 1999) and yet do they, and other woodpeckers, have a big impact on their surrounding area and fellow forest inhabitants. When winter

season is coming to an end, and spring is starting to blossom, other species start to come back from migration or hibernation. At this time the life of a bird is quite hectic and it is all about survival. Foraging, finding the perfect partner and nesting spot is what it is all about for most birds and forest animals during this time of year.

At the beginning of each spring both the male and female lesser spotted woodpeckers starts to make nests (Wiktander et al, 2000). The last year´s nest is not good enough and since female lesser spotted woodpeckers are quite picky the males often need to make several nests during each spring. As the lesser spotted woodpecker build approximately five nests per individual it is common to find more nests than there are individuals in an area (O. Olsson, pers. comm.). This leaves a lot of old and new nest holes, finished ones and unfinished ones. These holes make great homes for other, not as picky, species that also have a preference for nesting in tree cavities (Remm and Lõhmus, 2011). Since most other species cannot make their own cavities they depend on already existing holes and this is where the importance of the woodpeckers come in. Species like tits (Paridae), flycatchers (Tyrannidae) and owls (Strigiformes) also use cavities to nest in. It has been shown that the shortage of tree cavities in managed forests and plantations limits the breeding densities of some cavity-nesting birds. Therefore it is a possibility that the supply of woodpecker holes may in turn limit the populations of secondary cavity users (Gorman, 2004). It has even been shown that non-cavity making birds often choose an old woodpecker hole over a naturally formed one (Johnsson, 1994). One explanation could be that the woodpeckers carefully choose their nesting sites whereas a natural cavity appears more randomly (Gorman, 2004). In addition to other bird species, the woodpeckers' holes also attract insects like various wasps (Apocrita), bees (Anthophila) and hornets (*Vespa*) and sometimes mammals reuse them as well such as pine martens (*Martes martes*), red squirrel (*Sciurus vulgaris*), garden dormouse (*Eliomys quercinus*), edible dormouse (*Glis glis*) and various bat (Chiroptera) species (Gorman, 2004).

A meta analysis made by Remm and Lõhmus in 2011 examined 103 published studies regarding tree cavities and came to the conclusion that the Palaearctic region had the lowest median density of tree cavities. The presence of cavities were positively related to precipitation and

unmanaged forests regions (Remm, 2011). Woodpeckers are considered ecosystem engineers and provide, as mentioned before, other bird species with nesting spots and hideaways (Newton, 1998). They are therefore especially important in the cavity poor forest of the Palearctic region where the natural wood decay is prevented by either forest management or climate. And since some of the woodpecker species also can excavate nesting holes in middle aged forests they also provide housing for other species before a forest even gets old enough to form natural cavities on its own. The same goes for forest areas that has been exposed to fire, where the woodpeckers are the first to make cavities in the dead trees (Remm and Lõhmus, 2011). Woodpeckers are therefore highly important, not only for other species but to biodiversity itself.

According to the IUCN Red List the lesser spotted woodpecker is categorized as least concerned, LC (BirdLife International, 2016). But in Sweden it is now categorized as near threatened, NT, as the population has been declining. If the current decline continues this woodpecker will soon be vulnerable, VU (Petterson, B. 1987. Rev. Nilsson, S. G. 1995, 2001 and 2006). The lesser spotted woodpeckers can be found in most parts of Sweden, except some northern parts (Svensson and Grant, 1999). What affects the ongoing decline of the lesser spotted woodpecker is still being speculated. But the decline probably relates to the ongoing changes in woodland structure, intensified forest managements and fragmentation of forests. Problems that also are considered important to other bird species (Symes and Currie, 2005).

A study made by Wiktander et. al in 2001 has showed that the lesser spotted woodpeckers are most vulnerable in late spring when they have the highest mortality rate. This is mainly because of the high energy demands prior to their breeding season (Olsson et al. 1999). Lesser spotted woodpeckers are highly insectivorous and depend on dead snags in high trees which provide them with beetle larvae and other deadwood invertebrates. Therefore, a well-developed canopy with a high density of branches is important for their foraging behaviour (Symes and Currie, 2005). The estimated habitat area used during late spring foraging sets the minimum area requirement for the lesser spotted woodpecker and is approximately 40 ha. During winter the homerange could

be expanded to up to 1700 ha and the woodpeckers could even then be seen in forest types that they normally do not prefer such as spruce forests (Wiktander et. al, 2001). Normally the lesser spotted woodpeckers inhabit deciduous forests, preferably unmanaged ones, and not preferably coniferous trees (Olsson et al., 1992) and they are also sensitive to differences in percentage of habitat cover (Broughton et al 2013). The frequency of occurence of lesser spotted woodpeckers seems to increase with the total area of suitable habitat forest (Wiktander et al., 1992). This in turn means that they are dependent on large areas of these specific habitats to thrive during their most vulnerable time of the year.

In 1985 a large-scale project called “The Lesser Spotted Woodpecker Project” was initiated by Ingvar Nilsson at Lund University together with Börje Pettersson at the Swedish Agriculture University and the Swedish Ornithological Society, and many volunteers. The project aimed to map out the presence of the lesser spotted woodpecker and the forest compositions in several locations in south of Sweden. The collected data could later be used in future comparison studies and provide clues and possible answers to what may cause the decline of the Swedish populations. Follow up studies like these, where an organism and its habitat is monitored during a long period of time, are important to help and provide data for future conservation work. This has earlier been shown by Broughton et al in 2013 where they studied historical distribution pattern of marsh tits, willow tits (*Poecile montanus*) and lesser spotted woodpeckers in Britain in relation to changes in habitat (Broughton, R. K., et al, 2013). A decline in lesser spotted woodpecker populations have also been detected in Finland (Svensson et al., 1992). Accumulating data regarding the populations and habitat requirements of the lesser spotted woodpecker is highly relevant in order to prevent further reduction of the populations. In spring 2019 the Lesser Spotted Woodpecker Project will be re-done to make some awaited comparison studies.

My study will allow us to take a sneak peek of the upcoming results of the Lesser Spotted Woodpecker Project planned in 2019. With collected data from this year, 2018, gathered at 11 different localities in Scania, Sweden, comparisons will be made with the data from the 1980’s to try to detect any major changes. Regarding the

lesser spotted woodpecker three questions will be answered in this paper:

i) Is there any change in suitable habitat area?

ii) Has the presence of lesser spotted woodpecker changed since the last inventory?

iii) What has changed regarding the forest composition in the squares where the lesser spotted woodpecker does not occur anymore?

**Marsh tit**

In addition to the lesser spotted woodpecker, data regarding the presence of the marsh tit will also be collected and examined. According to the IUCN Red List the conservation status regarding the marsh tit in Sweden is today categorized as LC - Least concerned. But just as early as back in 2005 the marsh tit was categorized as NT - Near threatened (Nilsson J-Å. 2006 and Artdatabanken, SLU. 2006).

The marsh tit utilizes different types of food sources than the lesser spotted woodpecker. But the marsh tit still shares parts of its niche with the lesser spotted woodpecker since they both avoid conifer plantations and intensively managed commercial woodland, and prefer mature old trees (Olsson, pers. comm.). The marsh tit is vulnerable to forest fragmentation and rarely travels longer than approximately 35m in open landscapes (Nilsson J-Å. 2006 and Artdatabanken, SLU. 2006), and their area of habitat requirement is known to be at least 8-10 ha (Ola Olsson, pers. comm., Symes and Currie, 2005). The marsh tit is a great species to monitor when studying how forest continuity and connectivity is conserved. Something that is of great importance since fragmentation and deforestation is one of today's major reason for habitat and species decline (Broughton et al 2013). Marsh tits also rely on woodlands with large proportions of tree cavities, something that woodpeckers can provide them with (Symes and Currie, 2005). Not only do fragmentation and tree cavities limit the marsh tit populations but also interspecific competition, since other tit species also prefer nesting in cavities (Symes and Currie, 2005). Another tit species, the Eurasian blue tit (*Cyanistes caeruleus*) is dominating nest holes and easily outcompete the marsh tits. A serious threat that opens up another possible reason to why the marsh tit populations can decrease (Nilsson J-Å. 2006 and Artdatabanken, SLU. 2006).

Regarding the marsh tit two additional questions will be answered in this paper:
iv) Does the marsh tit occur in the same area as the lesser spotted woodpeckers?
v) Does the size of the connected suitable habitat area differ whether the marsh tit is present or not?

## Material and methods

**Field work**

For the field work a binocular together with bird- and tree guides were used. It is also recommended to use a compass or GPS when navigating in the forests.

The lesser spotted woodpecker was told apart from another very common woodpecker, the great spotted woodpecker (*Dendrocopos major*), by its body size and plumage where the great spotted woodpecker has a red bottom and two white oval shaped spots on its back which the lesser one is lacking. The nest holes were told apart from each other by estimating the diameters of the entrance hole.

During approximately one month, between mid april and mid may, I investigated 11 square shaped areas, of 200 ha each. The localities chosen were squares that had earlier been inventoried back in 1986 and 1987 during The Lesser Spotted Woodpecker Project. 15 localities were visited in the 1980's but since four of them (square 1, 2, 4 and 5) lacked biotope descriptions I chose not to investigate them again in this study. All localities were located in different parts of the region of Scania, Sweden. All squares had data over the presence and absence of the lesser spotted woodpecker together with biotope descriptions which includes the classification of biotope class and its age, thinning degree and the available nesting trees. Also the dominating tree species in each biotope area was noted. A more detailed description of the inventory procedure can be found in the method section of the Lesser Spotted Woodpecker Project (Petterson, B., 1985). The squares had a variation in woodland area among them and due to this some areas were visited only once and some twice depending on the time spent in each square. To be able to make a comparison study between then and now, I collected the same type of data as back in the 1980's. The former maps (1:10 000) of the squares were sometimes needed to be redrawn to match todays forest composition. I later calculated the size of each area inside the squares by measuring the areas on the new

edited maps, where 1 $cm^2$ represented approximately 1 ha. The suitable habitat area for the lesser spotted woodpecker includes the biotopes 1 (broadleaf forest), 3 (other deciduous forest), 5 (beach forest), 6 (alder marsh) and 7 (birch marsh). Other biotopes are not considered suitable due to their openness or content of conifers. Forest classified as young were also not considered as suitable. While out in the field, I could not reach some areas due to overflooding which lead to some missing data points. These areas were therefore not included in the dataset.

I also collected additional data regarding the presence and absence of the marsh tit to see if the marsh tit and the lesser spotted woodpecker occured in the same areas. This data was also used to investigate if difference in fragmentation of the forests affects the marsh tit. Each map was carefully studied and comparisons of connected suitable habitat area for the marsh tit between the 1980's and 2018 was made. Suitable habitat area for the marsh tit includes the biotopes 1 (broadleaf forest), 3 (other deciduous forest), 5 (beach forest), 6 (alder marsh), 7 (birch marsh), 8 (noble mixed forest) and 9 (other mixed forest). Other biotopes are not considered suitable due to their openness. This also includes areas with old beech (*Fagus*) forests, lakes and large rivers, cropland and areas containing only coniferous forests. If a gap of unsuitable biotope between two suitable habitat areas appeared to be larger than 0,5 ha that gap is considered too big for the marsh tit to cross.

**Statistical analysis**

To see if the suitable forest area for the lesser spotted woodpecker had gone through any major changes over the years I made a paired t-test. The t-test compared the total area of suitable habitat from all squares. I then performed a $x^2$-test to detect any major changes in presence of the lesser spotted woodpecker. I made graphs for each square to illustrate the changes in suitable habitat area, age, thinning degree and number of potential nesting trees. Due to the redrawing of the maps, which lead to a difference in sampling size, no paired t-test could be done to confirm any of these changes mathematically.

Another graph was made to illustrate when the lesser spotted woodpecker and the marsh tit occured in the same locations. The total area of the biggest coherent suitable woodland was checked

for each square to see if the area meets the marsh tits requirements of minimum 8 ha. I finally made an unpaired t-test to see if there was any difference in the biggest coherent area between the squares depending on if the marsh tit was present or not.

## Results

i) No significant difference was found in the total suitable habitat between then and now regarding the sum of total area of all the squares (p = 0.704, df = 10, t = 0.392).

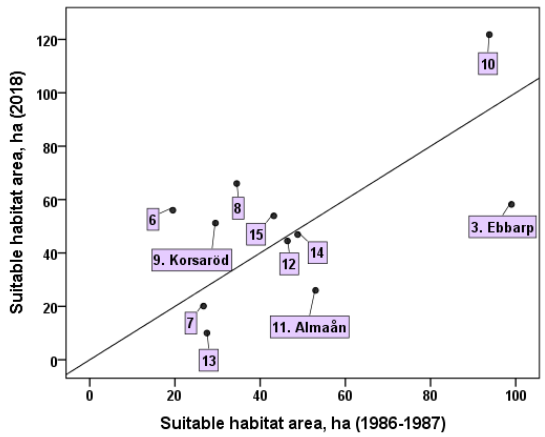


*Figure 1. Increase or decrease of total suitable habitat between the 1980's and 2018 in the different squares, Square 12 and 14 show no change. Note that square 3. Ebbarp, 9. Korsaröd and 11. Almaån have all undergone changes.*

ii) Regarding the presence of the lesser spotted woodpecker between now and then, no significant difference was detected either (p = 0.586, df = 1, $X^2$= 1.222).

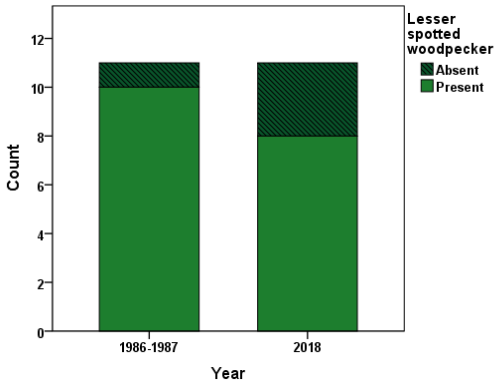


*Figure 2. The lesser spotted woodpecker is absent in two more localities now than in 1980's when it only was absent in one.*

iii) The lesser spotted woodpecker was absent in the following three localities

**Ebbarp**

The lesser spotted woodpecker has not been seen in this area.

Age structure:

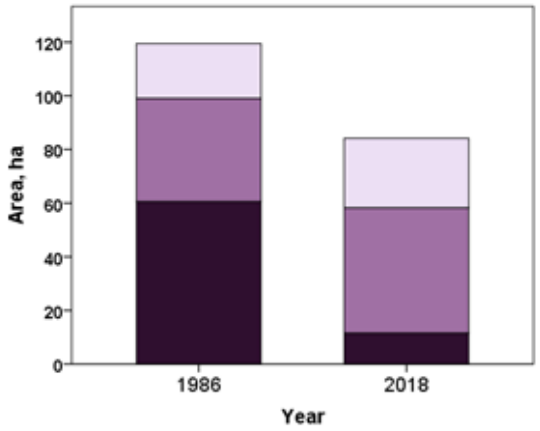


*Figure 3. The amount of old forest has declined with approximately 50 ha.*

Potential nesting trees:

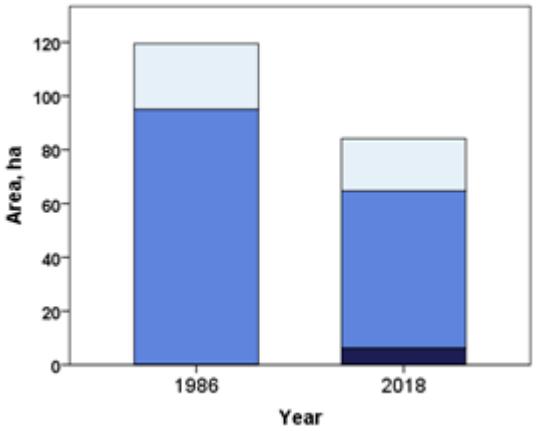


*Figure 5. Almost 10 ha containing many potential nesting spots has appeared.*

Thinning degree:

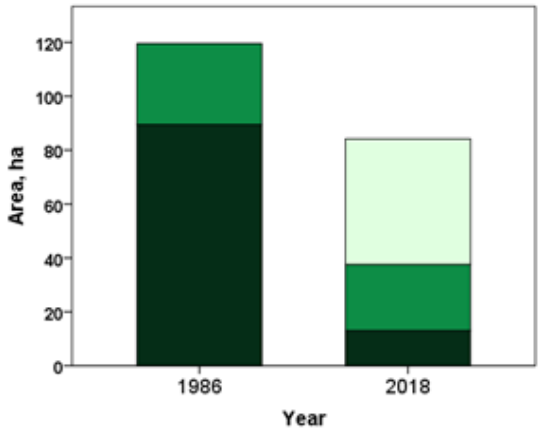


*Figure 4. Thinning has declined. Over 50% of the suitable habitat is left unthinned.*

**Korsaröd**

The lesser spotted woodpecker seems to have disappeared from this area.

Age structure:

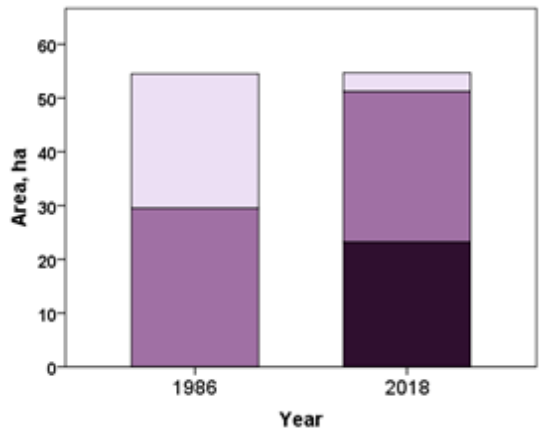


*Figure 6. An increase in area of old forest and decrease in young.*

Potential nesting trees:

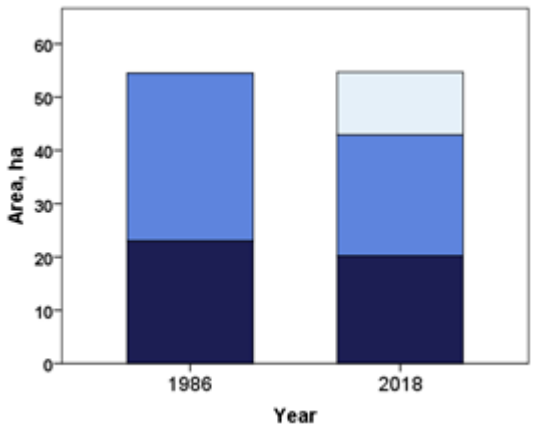


*Figure 8. Approximately 10 ha of the area with few nesting spots has been replaced by forest containing no nesting spots.*

Thinning degree:

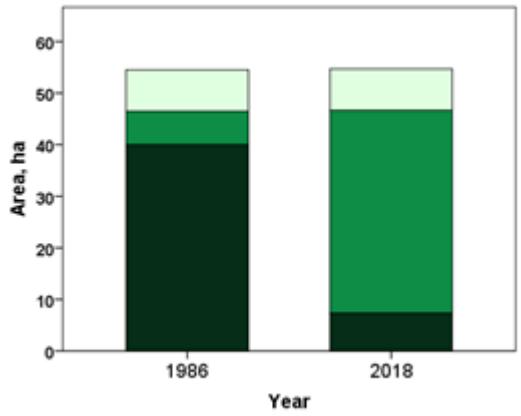


*Figure 7. A decrease in area of relatively fresh thinned forests (Thinned < 10 years ago).*

**Almaån**

The lesser spotted woodpecker seems to have disappeared from this area.

Forest age:

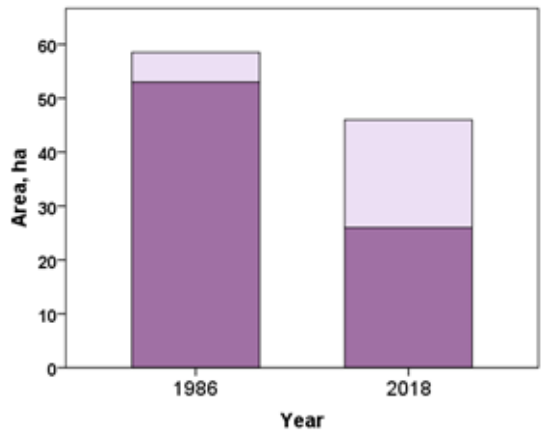


*Figure 9. No forest has been left to become old.*

Thinning degree:

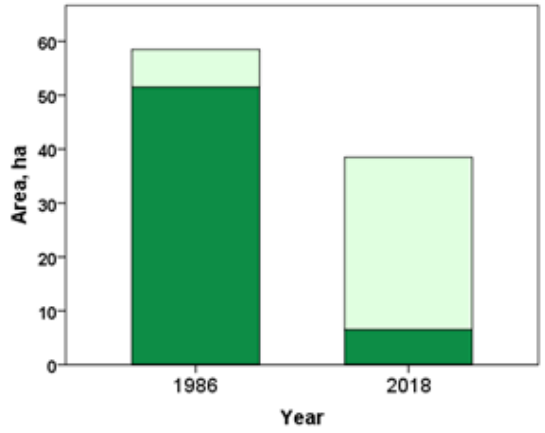


*Figure 10. Most of the area in 2018 is left unthinned.*

Potential nesting trees:

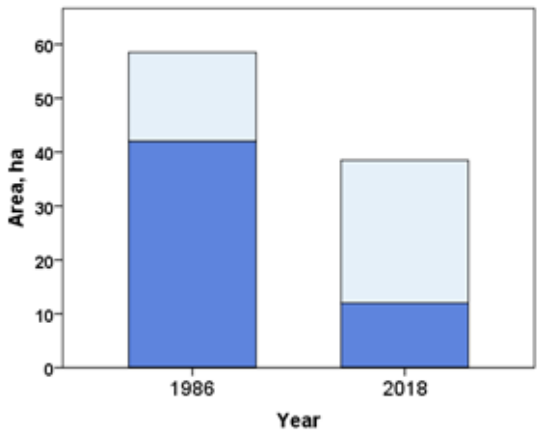


*Figure 11. Area with few potential nesting trees has declined with approximately 30 ha, leaving only 10 ha of few potential nesting trees in the whole square.*


In the other squares the lesser spotted woodpecker was present both back in the 1980's and in 2018. See appendix for graphs regarding the other squares.

iv) The marsh tit occurred together with the lesser spotted woodpecker in four out of 11 squares. The marsh tit did occur in seven out of the 11 squares.

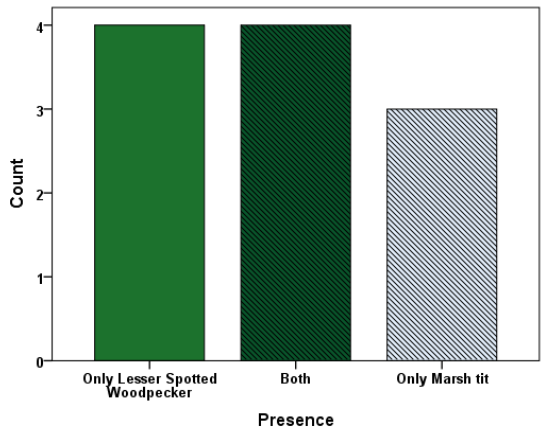


*Figure 12. Marsh tits occur together with lesser spotted woodpeckers in four out of 11 squares.*

v) All squares met the minimum coherent area requirement of 8 ha for the marsh tit. An unpaired t-test showed no significant difference in biggest connected suitable area between the squares depending on if the marsh tit was present or not ($p = 0.510$, $df = 9$, $t = 0.686$).

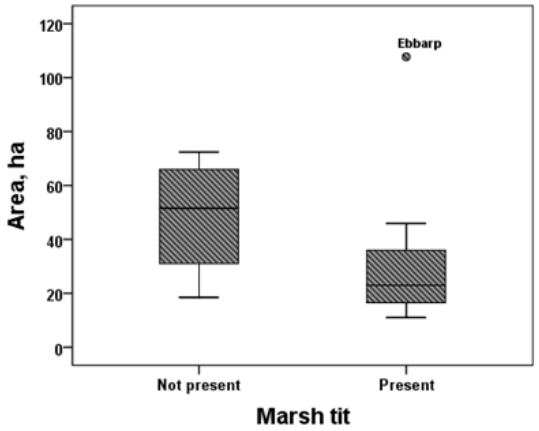


*Figure 13. No significant difference in size of the suitable habitat area for the marsh tit depending on its presence in the squares.*

Box plot of the data showed that the areas where the marsh tit was present all varied in areas between 20-60 ha except for one square, Ebbarp 3.

## Discussion

i) The t-test could not detect any significant change in total suitable habitat between the data from 1986-1987 and the data from 2018 (Figure 1). But it is important to remember that this comparison is made with data of the total habitat area from each squares summed up. There could be significant changes between individual squares but this could not be tested with a paired t-test since the area inside some squares have changed during the years which lead to a difference in sample size. Only two points, number 12 and 14, has

almost no change at all in total area of suitable habitat (Figure 1).

ii) According to a $X^2$-test there is no significant change in presence of the lesser spotted woodpecker. But a graph clearly shows us that the bird has disappeared from two squares where it previously in 1980's was present (Figure 2).

**Disappearance of the Lesser Spotted Woodpecker**

iii) Three out of 11 squares (3. Ebbarp, 9. Korsaröd and 11. Almaån) did not seem to have any lesser spotted woodpecker inhabited in 2018 and all three localities has undergone changes in suitable habitat area (Figure 1).

In square 3, Ebbarp, the lesser spotted woodpecker never seem to have been present either back in 1986 or today, 2018. This could provide us clues about the importance of the composition of our measured factors in this square. The total suitable habitat area has also declined from 100 to 60 ha (Figure 1). Out of that, the amount of old forest, which is a crucial habitat for the lesser spotted woodpecker, have seemed to decline with approximately 50 ha which only leaves 10 ha of old forest left in this square (Figure 3). On the other hand the thinning degree have declined and today just over 50% of the suitable habitat is left unthinned (Figure 4). A small area of approximately 10 ha has seemed to appear with several potential nesting spots. But the areas with few potential nesting spots has declined (Figure 5). The prerequisites for the lesser spotted woodpeckers are poor at this locality. Especially as the conditions were poor already back in 1986 they sure have not improved.

Regarding square 9, Korsaröd, the lesser spotted woodpecker seemed to have disappeared from this locality. According to my dataset no nests or birds of the lesser spotted woodpecker was found there in spring 2018. By taking a closer look at the different measured factors in this area it is hard to draw any conclusions wether forest age, thinning degree or area with potential nesting trees could have any large impact on the birds disappearance. Forest age and the thinning degree have improved and should favour the lesser spotted woodpeckers (Figure 6, Figure 7). And in the case of amount of potential nesting trees this factor has only declined with approximately 15 ha (Figure 8). And this decline applies to the areas with few potential nesting spots and not the areas with many potential nesting spots which has remained the same. Also, the total

suitable habitat area for the lesser spotted woodpecker has increased by approximately 20 ha (Figure 1). This is a very good sign in contrast to the two other squares (3. Ebbarp and 11. Almaån), where the lesser spotted woodpecker today also is absent and has declined in this factor. The disappearance of the lesser spotted woodpecker in this square, 9 Korsaröd, could have been a simple miss. Korsaröd was the first area visited in mid april, right before spring started to blossom, and it is possible that the woodpeckers had not begun their intense drumming and nest building yet, as old nesting holes did occur in the square. During the inventory the weather was cold and snowing in contrast to the weather during the visit of most other squares where it was typical sunny spring weather. According to my supervisor, Ola Olsson, the square at Korsaröd did not seemed to be optimized when it had been placed and by moving the square just a little, more suitable habitat could have been accounted for which then could have made a difference in the results.

Lastly in square 11, Almaån, the lesser spotted woodpecker also could not be found anymore. This area has not been improved in any of the forest factors measured. No amount of forest has been left to become old (Figure 9) and the total suitable habitat area has declined with approximately 20 ha (Figure 1). But the results show that most of the remaining area has remained unthinned (Figure 10) which contradicts the fact that no old forests were found in the area. At the same time the amount of young forests has increased with 15 ha and now takes up almost 50 % of the remaining area (Figure 9). Young forests can be very dense and hard to go through so it is possible that these young forests have been classified as unthinned when they actually were thinned < 10 years ago. Regarding the factor of potential nesting trees there has also been a major decline (Figure 11). The square did not have any areas with many potential nesting trees and neither does it now and the areas with few nesting trees have declined with 30 ha. This leaves only 10 ha with few potential nesting spots in a square with a total area of 200 ha, which is very low. All collected data from square 11, Almaån, suggests that the new unfavoured forest structures may be the answer to the lesser spotted woodpeckers' disappearance from this location. And sadly, there seemed to have been no intention of improving the conditions for the lesser spotted woodpecker.

**Marsh tit**

iv) The marsh tit do occur together with the lesser spotted woodpecker in some squares, four out of 11 (Figure 12). The other squares have either the marsh tit or the lesser spotted woodpecker present. It was expected to have them occur together in more squares since they both do prefer and require almost the same type of habitats. The marsh tit is dependent on small cavities in trees for nesting, which the lesser spotted woodpecker provide and therefore it would be beneficial for the marsh tit to occur along with the lesser spotted woodpecker. If data on other species were to be collected, such as the blue tit, interspecific competition between the two of them could maybe explain the absence of the marsh tit.

v) Since all squares met the minimum coherent area requirement of 8 ha for the marsh tit no square can be excluded as an unsuitable habitat for the marsh tit regarding that factor. And since no significant difference could be detected in the size of the connected suitable habitat area between the squares, depending on the presence of marsh tits, no specific area restrictment can be confirmed from this data set (Figure 13). But it is important to note the small sample size and that only the areas within the squares are counted for. The habitat outside the squares can either be for example further suitable forests or further unsuitable open farmland. It was not noted on the maps where the marsh tit was seen or heard. Since the woodland areas sometimes were fragmented across the square and created several patches of suitable habitats there is a risk that the wrong patch was accounted for since always data from the biggest coherent area was used, and the marsh tit could as well have been spotted in some of the smaller patches.

A few potential errors needs to be addressed since it could have an impact on the results and my conclusions. The former collected data on presence of lesser spotted woodpecker was made only if song, call or drumming was heard from the bird. The collected data in my study consisted of actually seeing the bird or by finding fresh nesting holes in the squares. Looking for nesting holes was not part of the methods of the inventory made back in the 1980's. Since I mainly focused on finding nesting holes and seeing birds my data should have a better support when pointing out wether the squares actually are inhabited by the lesser spotted woodpecker or not. This as I consider

myself being a novice ornithologist and my lack of knowledge of bird song, call and drumming could have then impacted the collected data. In one square (Almaån, 11) only a call of, what I believed to be, a lesser spotted woodpecker was heard. To avoid a potential mix up this one datapoint on the presence was removed. But this removal seemed fairly accepted since no nesting holes were found in that particular square either. Another difference is that in the 1980's each square was visited five times and if any unsure data points occurred there was time for them to be affirmed later in another visit. Whereas in my study a square was only visited once or in few cases twice.

There is a possibility that the biotope descriptions from the 1980's varied in quality and accuracy since in some squares some single biotope areas took up fairly large space. For example in one particular case, square 6. Betlehem. One area at this location consisted of almost 100 ha of one biotope and this area today could be divided up into several different biotopes of great importance when describing the woodland composition for the lesser spotted woodpecker. This needs to be taken into account when drawing any conclusions from this study since it may affect the results when making the area comparison between then and now in all measured factors.

**Conclusions**

The reduction in biodiversity is an alarming threat to both humans and other living species on this planet. Conservation actions regarding the lesser spotted woodpecker is highly relevant because of their highly important role as biological engineers in woodland habitats. Many secondary cavity users are highly dependent on their nesting holes and would be long gone without cavity creating species such as the lesser spotted woodpecker. Naturally occurring cavities become rarer as forest management gets more intense. Earlier research has pinpointed a "weak spot" where the abundance of insects during late spring is highly important for the lesser spotted woodpeckers survival. By focusing on preserving old forests with high amount of dead wood and also preserving specific tree species that provide the lesser spotted woodpeckers with insects, hopefully the declining populations can begin to regain their strength. Preserving old forests also increases the biodiversity of many invertebrates which is of great importance since a rapid decline in insect biodiversity

has recently been detected in Europe (Hallmann et al., 2017). Some may argue that the importance of the lesser spotted woodpeckers nest is lower than nests of larger woodpecker species because of their small diameter size of the entrance holes. But regarding the marsh tit, a smaller entrance hole is preferred and the lesser spotted woodpecker nests are of even greater importance since the marsh tits are highly dependent on these nesting holes and marsh tits do not use next boxes readily (Symes and Currie, 2005). Smaller holes will, with time, expand and possibly be more suitable for other species, in the future. Species like the great spotted woodpecker is already abundant in Swedish forests and provides bigger nest holes for other species. By preserving the lesser spotted woodpecker other species benefit too, and since it is common that woodpeckers follow other bird species such as tits, nuthatches (*Sitta*), treecreepers (Certhiidae) and goldcrests (*Regulus regulus*), this possibly to lower their predation risk, the lesser spotted woodpeckers benefits from the existence of other species too (Wiktander et. al, 2001). It is important to understand that many species depend on each other and a high biodiversity is needed for healthy and functioning ecosystems. So by preserving habitats such as old unmanaged forests we help the lesser spotted woodpeckers to regain their viability and also help other species such as the marsh tit as a bonus.

**Future recommendations**

A way to maintain a high biodiversity is to aim to preserve the right species. As the lesser spotted woodpecker is seen as a biological engineer and provides other species with important woodland structures such as nesting holes it has a high conservation value. By making schemes on when and how to manage forests, and rotating the management with time, you can make sure that the forests contain a full range of growth stages. Longer rotations may favour species such as lesser spotted woodpecker as forests are able to grow old. Preserving dead trees and snags not only helps the lesser spotted woodpecker in form of potential nesting trees but also provides them and many other woodland animals with a variety of invertebrates to feed on. Further studies regarding the lesser spotted woodpeckers' biotope and specific tree preferences could help pinpointing their requirements and make more precise strategies for conservation work.

Closer behavioural studies regarding interspecific competition can be done between the lesser spotted woodpecker and the marsh tit by observing how many of the lesser spotted woodpeckers nesting holes are being reused by the marsh tit. Comparing more and less fragmented woodland could be an efficient way to study how fragmentation limits marsh tit populations.

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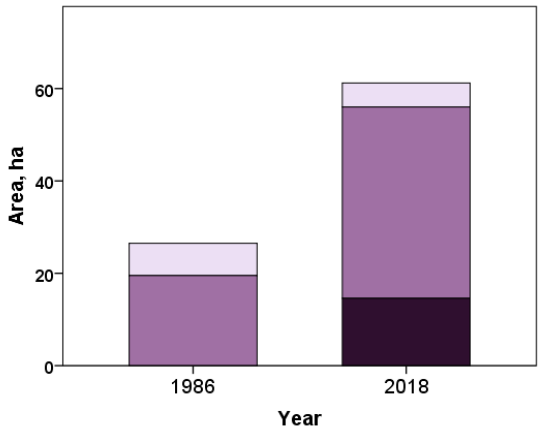
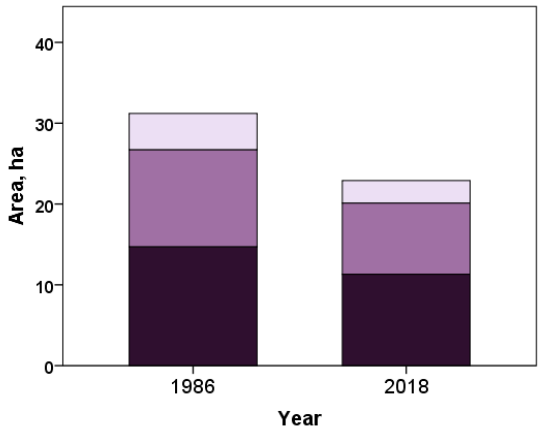
# Appendices

**Forest area according to the age classes**

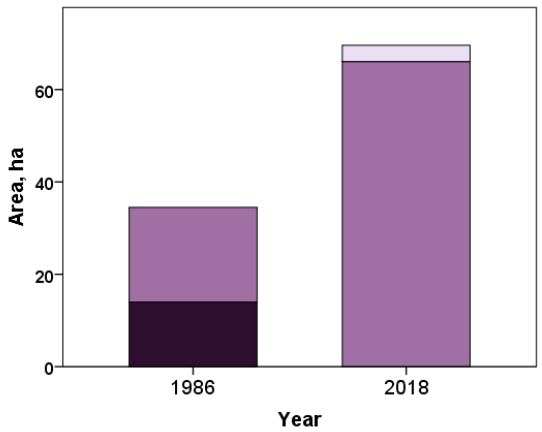
6. Betlehem



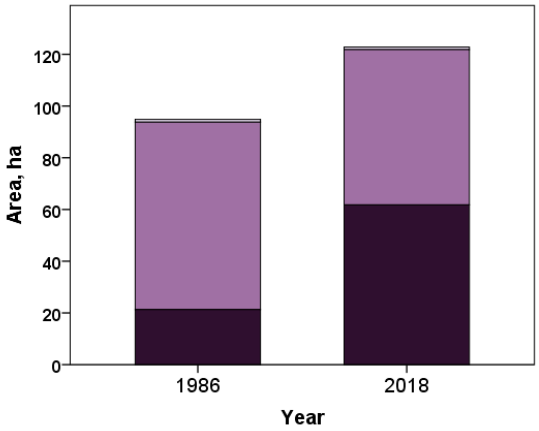

7. Bellinga



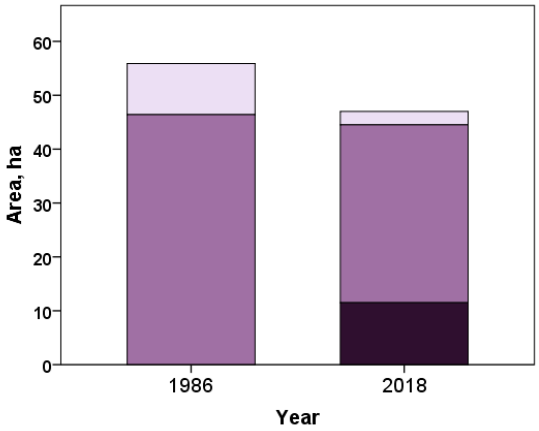

8. Åraslövs mosse



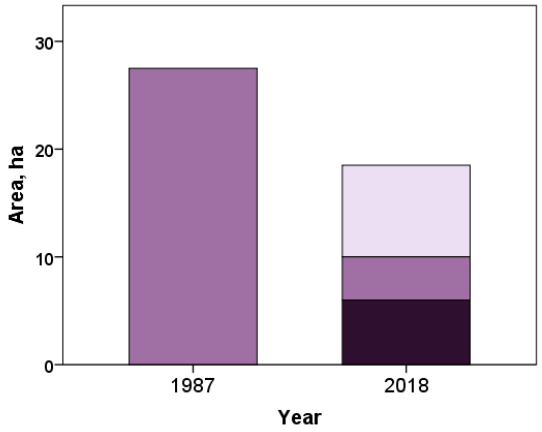

10. Spragleröd



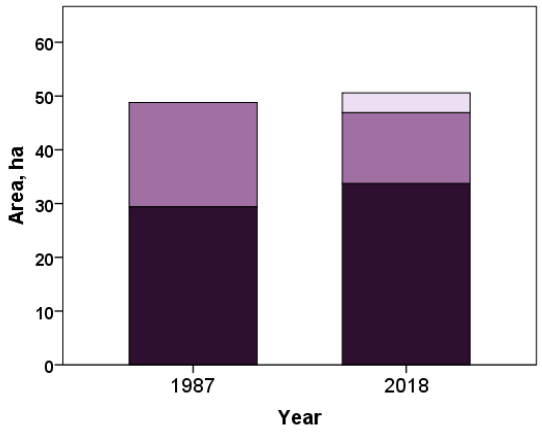

12. Mjölkalånga



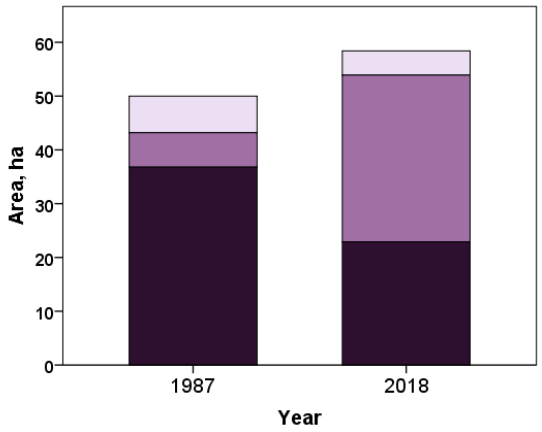

13. Ekenabben




14. Stianderöd

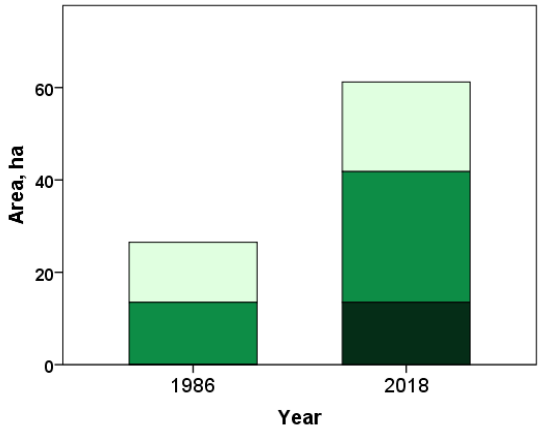



15. Navröd




**Forest area according to thinning degree**

6. Betlehem

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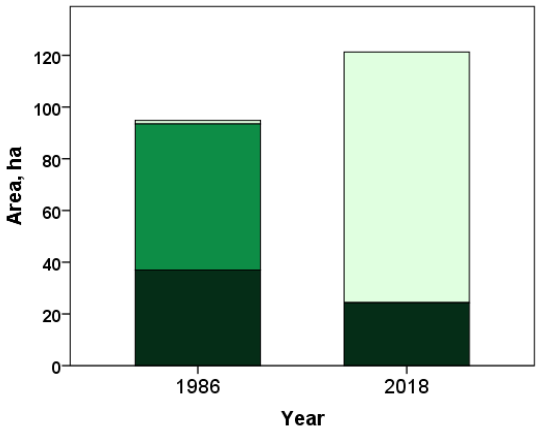


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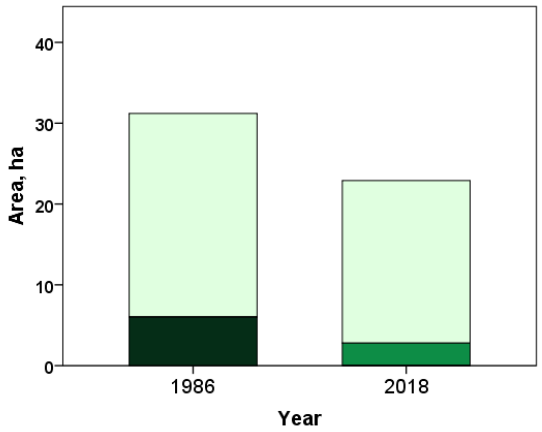


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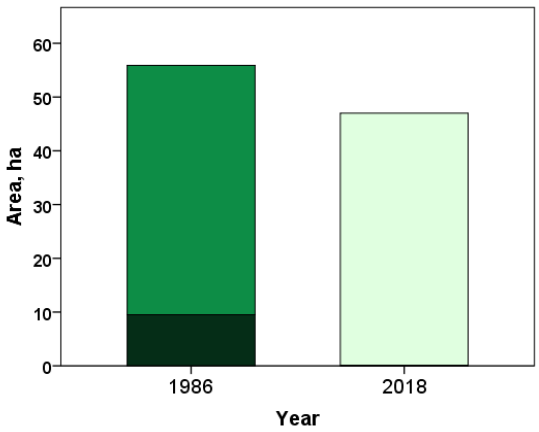
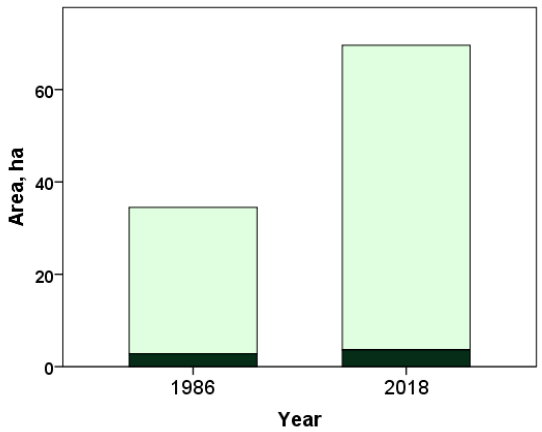



8. Åraslövs mosse

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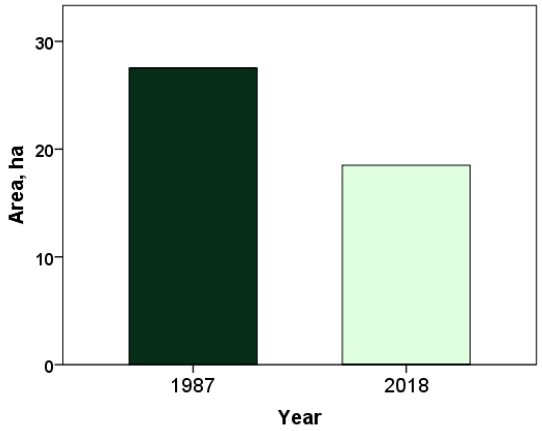


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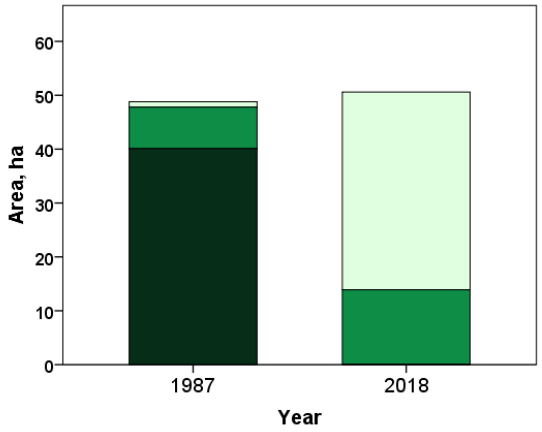


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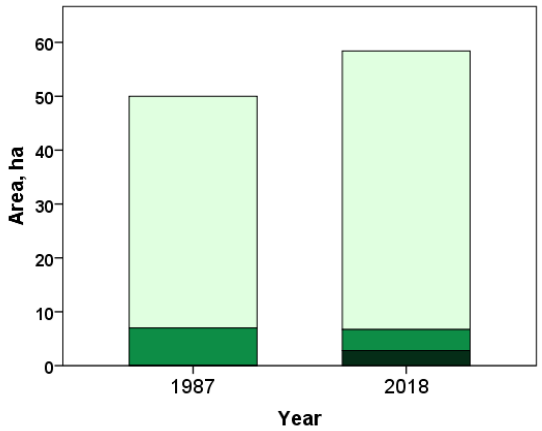
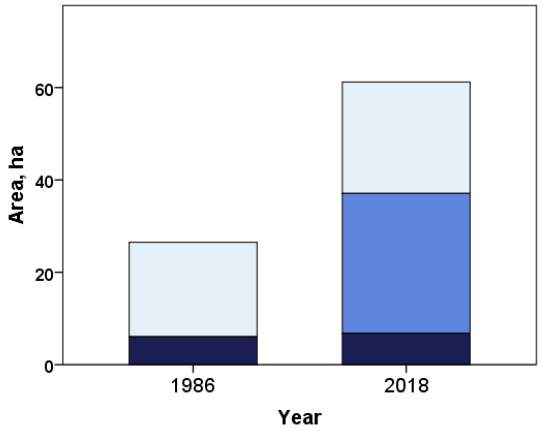



**Forest area according to amount of suitable nesting tree**

6. Betlehem

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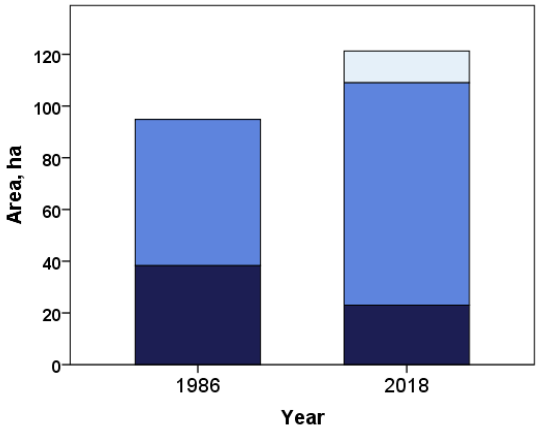


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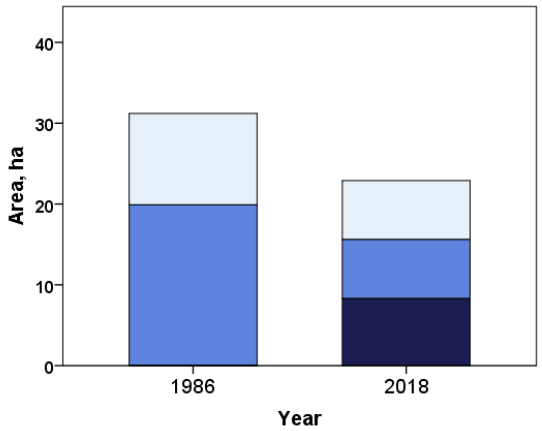


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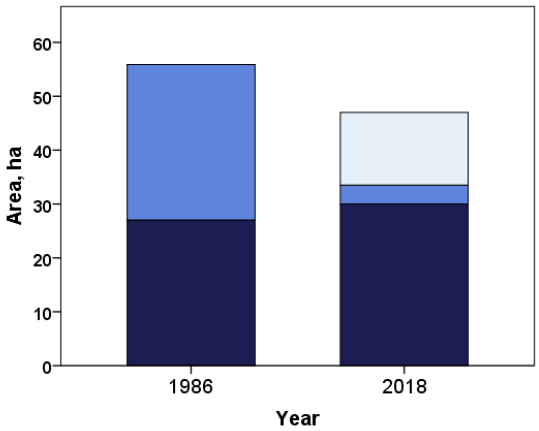


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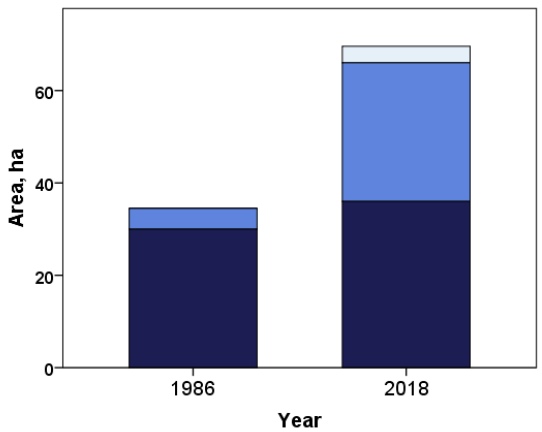


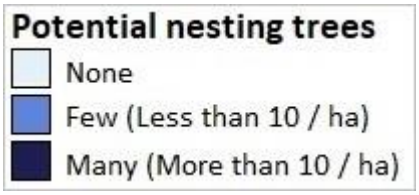

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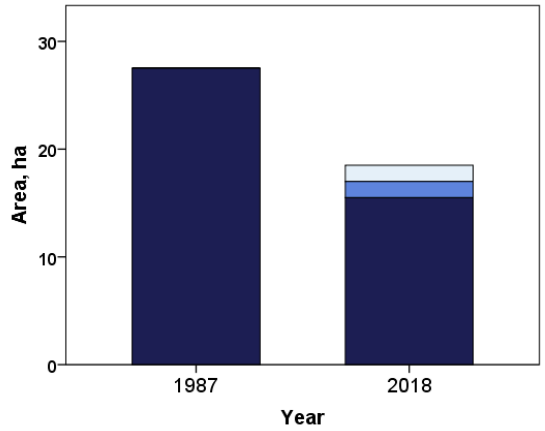


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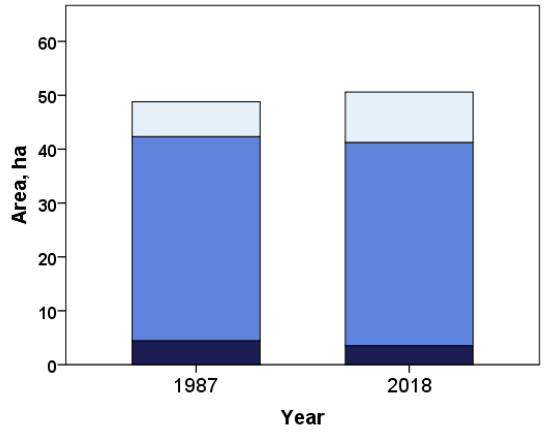


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