Stand characteristics and temperature's effect on bilberry availability and quality

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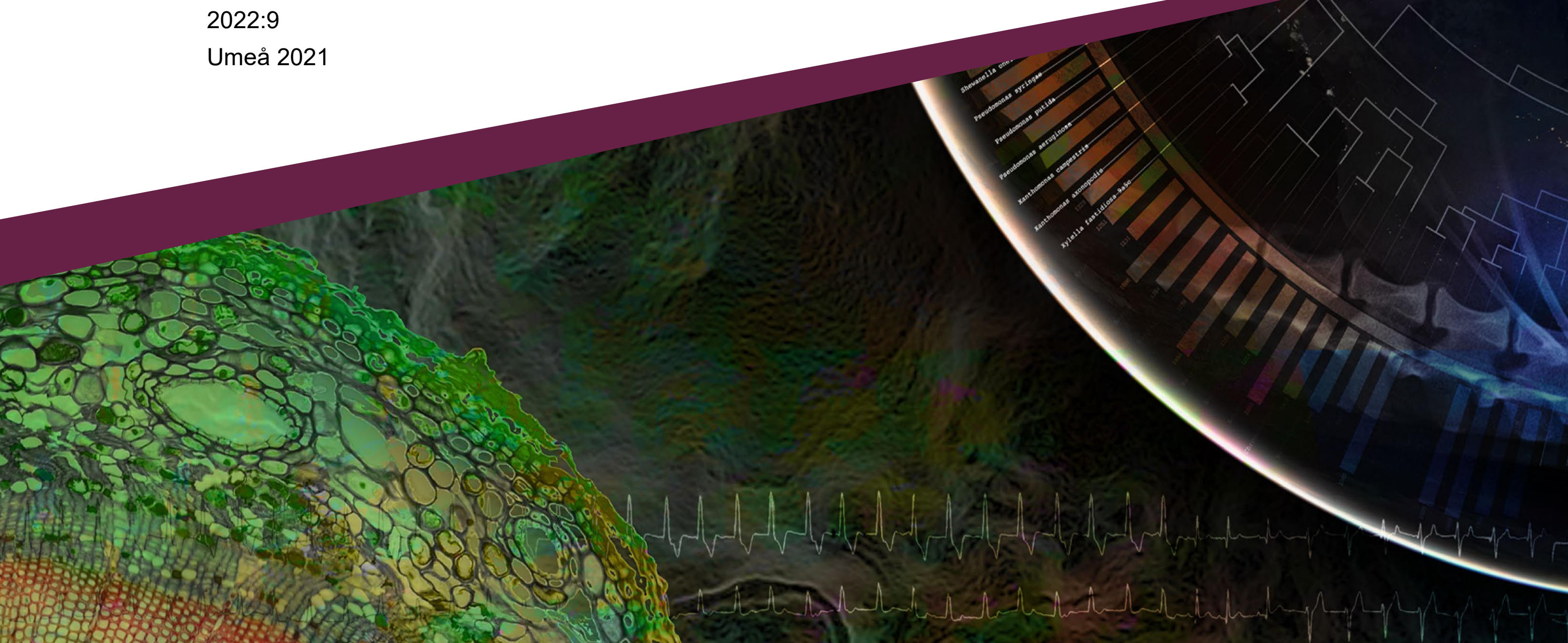

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Abstract

Stand characteristics is a crude description of a forest and provides general knowledge of what the forest looks like, for example plant composition and site productivity. Factors and measurements like tree canopy and basal area affects the near ground microclimate through temperature regulation, light intake, and available soil nutrient. This study focuses on the effect of stand characteristics and temperature on availability and quality of the ericaceous dwarf shrub bilberry, *Vaccinium myrtillus*. The data used derives from central Södermanland, Sweden, and has been collected during a short time-period of two weeks by the end of March this year, 2021. The temperature loggers were installed the previous year and retrieved this year. Day temperature decreased with increased basal area while the night temperature was affected by maturity classes. There was a significant difference between bilberry coverage and maturity classes. A further pairwise comparison revealed the difference to be between final harvest and the other maturity classes. However, when looking at bilberry weight, it was only positively correlated to bilberry coverage. The quality of the dwarf shrub as forage, defined as Total Digestible Nutrients, was affected by neither maturity classes nor the weight. By connecting bilberry to suitable silviculture practise and longer rotation periods may increase the availability and thus mitigating ungulate related forest damages.

Keywords: Bilberry, *Vaccinium myrtillus*, nutrition, maturity classes, temperature loggers.

Table of contents

List of figures

Abbreviations

ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
KW	Kruskal-Wallis test
SLU	Swedish University of Agricultural Science

1. Introduction

Stand characteristics is a crude description of a forest site. According to the website *skogskunskap.se*; stand characteristics includes factors that describes the vegetation, ground type (i.e., mineral soil or wetlands), and water availability, which can be used as an indicator of a stand's productivity level (https://www.skogskunskap.se/ordlista/s/standortsegenskaper/). This description gives an insight of what a forest stand looks like, but also what can be expected from the stand in terms of species composition and plant quality (Hertel et al. 2016). Tree canopy and basal area (i.e., "the area in square feet of the cross section of a tree at breast height"; Hovind and Rieck 1961) in a forest stand are important characteristics affecting the microclimate on the forest floor since the overstory species regulates factors influencing growth such as light, temperature, water, and soil nutrients (Verheyen et al. 2012; De Frenne et al. 2013; Hedwall et al. 2013). By regulating these factors influencing growth, overstory species affects the occurrence of understory plant species, due to their ability to regulate incoming light to the forest floor (Neufeld and Young 2014), influence below-canopy climate (Greiser et al. 2018), and affect below-ground competition for soil nutrients (Coomes and Grubb 2000). Tree canopy can mitigate maximum and minimum air temperature, decreasing its amplitude near the ground (Vanwalleghem and Meentemeyer 2009). Tree canopy limit air mixing, force evapotranspiration and absorbs radiation, separating the macroclimate from the microclimate in the forest understorey (Von Arx et al. 2012). Plants have adapted to local temperature variations and may emigrate if local temperature conditions were not ideal or expand to more optimal locations (Kardol et al. 2014). However, some species may not adapt fast enough and disappear (Jozefat 2015) or take the opportunity to expand their range (e.g., expanding tree-line forest) (Hallinger et al. 2010). For example, Bokhorst et al. (2011) states that extreme winter warming events had clear negative impact on dwarf shrubs reproductive effort and shoot survival.

Changes in a forest stand, for example forest harvesting, may alter a stand dramatically (e.g., increased light intensity, air temperature changes, air humidity decreases) thus changing the microclimate and the present species composition (Wagner et al. 2007; Soto et al. 2015). Tree-less habitats (e.g., clear-cuts) will have more fluctuating temperatures (Häntzschel et al. 2005). Which impacts plant growth and development since all plants has an optimum temperature range

(Hatfield and Prueger 2015). Herbivores (e.g., ungulates and insects) may also inhibit the expansion and growth of trees and shrubs (Olofsson et al. 2009). All things considered, plant availability and quality depend on different environmental factors like stand characteristics, temperature, light, precipitation, altitude, and soil fertility (Selås 2006; Reiger et al. 2008; Krüger et al. 2011; Uleberg et al. 2012; Elisabetta et al. 2013; Hertel et al. 2016), which is affected by the dominant tree canopy, shrubs at different maturity levels, as well as the severity of any disturbance (Stone and Wolfe 1996; Légaré et al. 2002; Clinton 2003; Barbier et al. 2008).

Bilberry, *Vaccinium myrtillus*, is a common ericaceous dwarf shrub of the Eurasian boreal forest (Kardell 1979; Eldegard et al. 2019). The deciduous dwarf shrub prefers partially shaded, around 50 % canopy cover (Storch 1993), acidic coniferous forests (Coudon and Grégout 2007; Eldegard et al. 2019) and will be outcompeted by pioneer shrubs and trees, additionally when the canopy cover starts to close (Kardell 1979; Kardell and Eriksson 2011). Dense young forest is also an unsuitable environment due to the available light being limited by other light competing plants (e.g., pioneer species) (Kardell and Eriksson 2011). Bilberries will also decrease in numbers after a clearcutting due to the processes of harvesting, scarification, and replanting, the reduction of plant cover may reach 70% (Kardell 1979; Atlegrim and Sjöberg 1996). During winters, bilberry require a stable insulating snow cover and stable temperatures (i.e., frost sensitive) while flowering (around May), it is also sensitive to high precipitation and drought stress during fruit ripening (June to July), and high temperatures during bud formation (August to September) (Selås 2000; Hertel et al. 2018). The dwarf shrub spreads through rhizomes and seed dispersal by mammals and birds (Flower-Ellis 1971). Bilberry is considered a keystone species since many vertebrate and invertebrate species consumes the dwarf shrub's twigs, leaves, flowers, and flower buds (Selås et al. 2011; Hertel et al. 2016), and it is also indirectly important for the species that prey on those that feed on the dwarf shrub (Atlegrim 1989; Jedrzejewska and Jedrzejewski 1998). Bilberries have the capacity to recover from grazing damages, as well as shoot damages caused by frost (Tolvanen 1997), by mobilizing stored nutrients into regenerative growth (Tolvanen et al. 1994).

Bilberry has an important role as a food source for herbivores, insects, and birds that feed on the dwarf shrub, and for those that feed on the dwarf shrub consumers (Storch 1993; Selås 2001). Furthermore, the economic value of bilberry picking, especially in Sweden and Finland, is not to be neglected (Jonsson and Uddstål 2002; Vaara et al. 2013; Sténs and Sandström 2013). An understanding of bilberry availability as forage may aid in finding trade-offs in co-management of deer and forests, thus potentially mitigating forest damage. For example, moose consume more pine when competing with other ungulates for forage (Spitzer 2021). Bilberry quality and availability should be at its highest in partially shaded coniferous forests (Coudon and Grégout 2007; Eldegard et al. 2019) with mild stable temperatures

(Selås 2000; Hertel et al. 2018). In other words; forests of later successional maturity classes (i.e., an expression of a forest successional stage and upcoming procedure; Nationalencyklopedin 2021). To get an understanding of which factors affect bilberry availability and quality, I investigated the effect of stand characteristics and temperature on the deciduous dwarf shrub. In this project I used a short-term data set to compare different stand characteristics and temperature effect on bilberry availability and quality. Further analysis determined which factors influenced bilberry quality and availability. The results give insight to determining factors of bilberry availability and quality which could be used to help mitigate potential forest damages.

2. Material and Method

2.1. Study area

The observations and measurements for this study were conducted in central Södermanland, Sweden. The area is situated in the temperate zone, characterized by its cold summers and rather mild winters (Beck et al. 2018). Moose, red deer, fallow deer, roe deer, and wild boar are all present in the area. Throughout the study area exist 51 tracts in an even pattern with 16 sampling plots within each tract. The sampling plots are set in a square formation with a distance of 200 metres between each plot (Figure 1). The tracts are monitored yearly between March and April and started back in 2012.

2.2. Data collection

Within each sampling plot, measurements of stand characteristics were taken, such as basal area, species composition and water availability, as well as more ungulate related measurements, for example pellet count, browsing pressure and forage availability. There were also temperature loggers (iButtons), installed in 2020, in every tract to collect, one in every cardinal direction, if possible. The temperature loggers were set at a height of 0.5 metres, attached to a tree branch or similar. The measurements were conducted by the field technicians from SLU (Swedish University of Agricultural Science).

In a subset of sampling plots where an iButton had been placed, I cut and collected bilberry samples. Firstly, I collected bilberry (i.e., bilberry weight) by cutting shoots and twigs thinner than 4 millimetres in diameter with pruning shears during 5 minutes at a steady pace that would represent ungulates foraging on the dwarf shrub. The sample was weighed and then I cut more bilberry shrubs to reach a weight of at least 100 grams, if needed, for future nutritional analysis. The sampling area of bilberry weight was not restricted by the sampling plot's area (i.e., I cut and collected bilberry within and outside of sampling plots).

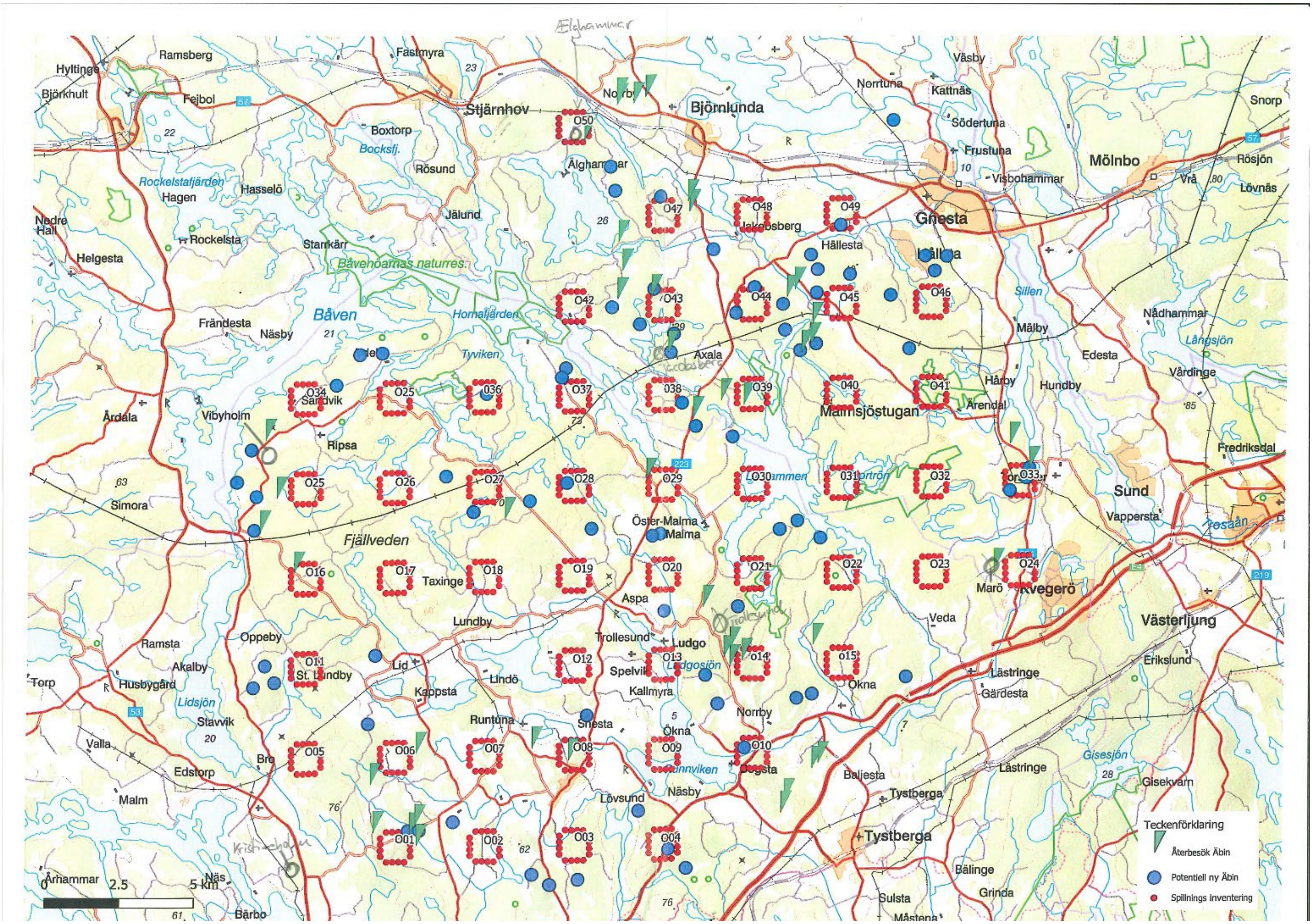

Figure 1. Map over the study area, Öster Malma, in central Södermanland, Sweden. The red dots represent the sampling plots, and each square formation is a tract. The blue dots and green arrows are to be ignored since they are not included in this study.

Subsequently, all bilberry samples were stored in drying ovens and dried in their bags of collection, open, some in zip-lock bags and others in plastic trash bags, at a temperature of 60 °C for at least 48 hours. Once dried, I ground all of the samples through a 1.0-millimetre screen and put the content in plastic containers which then was sent to Dairy One Forage Lab, Ithaca, New York, USA, for wet chemical analysis. Relative feed value (i.e., indicator of forage value) and lignin percentage was the quality variables analysed.

$$aov(dependent\ variable \sim independent\ variable + covariate)$$

Equation 1. The equation used for the analysis of covariance (ANCOVA) in R.

2.3. Analysis

Prior to conducting analyses, I carried out assumption checks, the assumption of homogeneity. Levene's tests were used to test the homogeneity of variances across stand classes, *leveneTest*, from the R package *car* (Fox et al. 2020). When significant deviations were found, I used non-parametric Kruskal-Wallis test, *kruskal.test,* instead of ANCOVA. A pairwise comparison revealed, *pairwise.wilcox.test*, between which groups the difference were. However, if the assumption was met, I used the *aov* function from the R package *car* (Fox et al. 2020; Equation 1.) to perform an ANCOVA. Thereafter, if there proved to be a significant difference, a Post Hoc test was required to pinpoint between which independent variables there was a significant difference. The Post Hoc was done using the *glht* function from the R package *multcomp* (Hothorn et al. 2021). Linear regression, *lm,* was applied when examining corelation between continuous variables. However, when a linear regression was not suitable, a Spearman correlation, *cor.test*, was applied instead. All my analyses were done in R under the version R-4.0.3.

The Levene's test was performed to verify which variables would meet the assumption of homogeneity, a p-value above 0.05 would satisfy the assumption criteria. All but basal area and bilberry coverage passed the Levene's test. However, basal area passed the assumption after a square root transformation and 0-values removed, which is the basal area used in the analysis.

3. Results

Out of the 816 sampling plots 496 were in a forested area with identifiable maturity classes, clear-felled areas (n=45), pre-commercial thinning (n=58), thinning (n=197), and final harvest (n=196). I removed classes that did not include production forest (n=44), such as the classification of final harvest forest that should be left standing out of nature conservation reasons. The temperature data was divided into two groups of average temperature at midday and midnight during the summertime. The average midday temperature during summertime was around 19.4 °C and dropped to an average of 10.3 °C at midnight (Figure 2). The highest average basal area was in final harvest maturity class, 18.4 m^2/ha, while the lowest average was found in clear-felled areas, 3.5 m^2/ha.

There was a significant difference in basal area between maturity classes (ANOVA $F(3,473) = 84.7$, $p < 0.001$). The average midday temperature were affected by basal area (ANCOVA $F(1,47) = 4.6638$, $p = 0.0359$) and decreased in temperature at higher basal area ($F(1,50) = 7.759$, $r^2 = 0.1343$, $p = 0.0075$), whilst unaffected in maturity classes after controlling for the effect of basal area (ANCOVA $F(3,47) = 1.7264$, $p = 0.1744$). The opposite effect can be observed on the average midnight temperature which was not significantly affected by basal area, (ANCOVA $F(1,47) = 0.8597$, $p = 0.3585$), but showed a significant effect of maturity classes after controlling for the effect of basal area (ANCOVA $F(3,47) = 7.0280$, $p < 0.001$). A Post hoc revealed the difference among groups to be between thinning and pre-commercial thinning, as well as final harvest and pre-commercial thinning ($p < 0.05$).

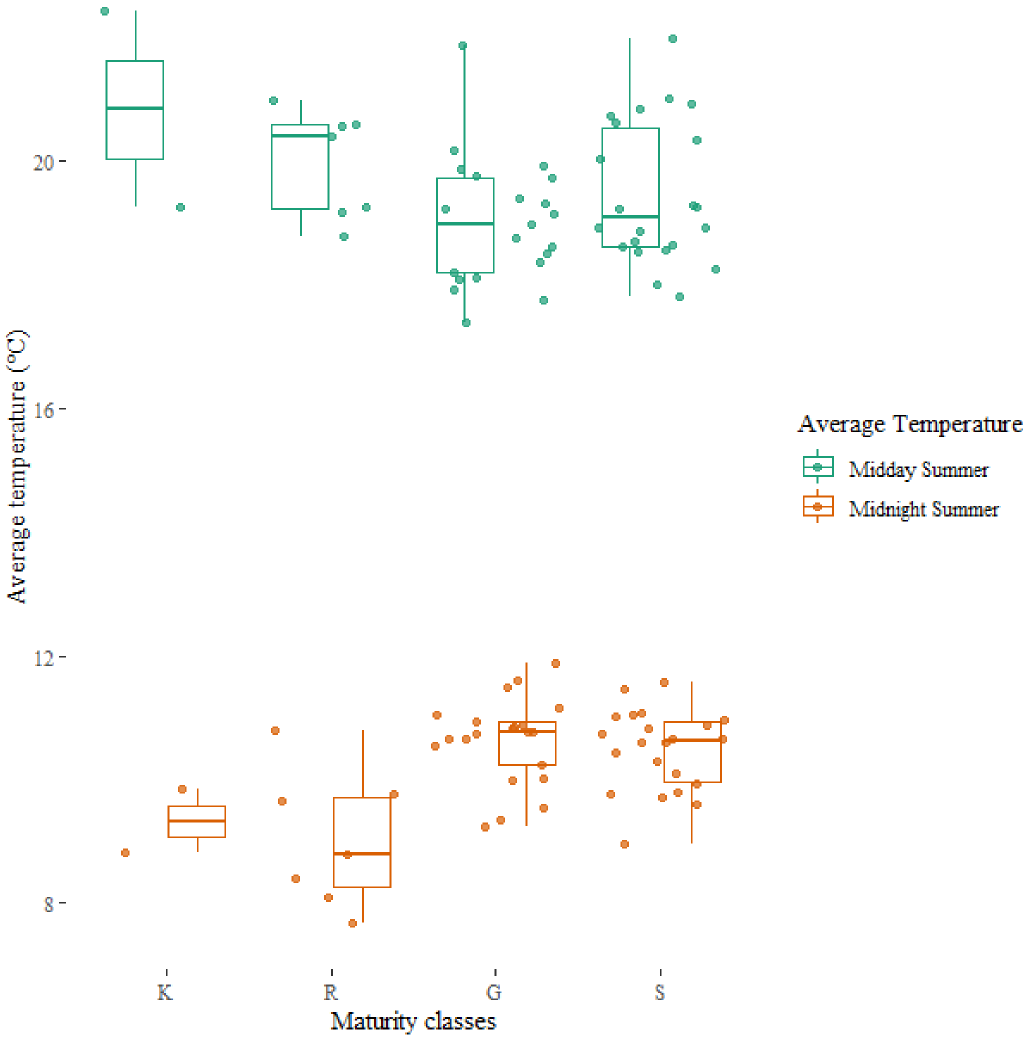

Figure 2. The sampling plots' average midday and midnight temperatures during the summer in each maturity class. K stands for Clear-felled area, R for Pre-commercial thinning, G is Thinning, and S stands for Final harvest.

Bilberry coverage was at its highest percentage in final harvest forest, 12.5 %, followed by thinning, 6.03 %, pre-commercial thinning, 3.93 %, and lastly clear-felled areas, 1.56 %. The majority of the samples was collected from final harvest areas (Appendix 1). Bilberry weight after 5 minutes of cutting was marginally higher in final harvest, 45.1 g, than thinning, 42.2 g, and last clear-felled area, 17 g. No bilberries were cut in pre-commercial thinning forests (Appendix 1), while most of the samples were cut in thinning areas.

I analysed bilberry coverage and weight after 5 minutes of cutting as variables of interest to understand the effect of maturity classes. The bilberry coverage differed between maturity classes (Kruskal-Wallis $H = 2.55$, $df = 3$, $p < 0.001$). The difference was between final harvest and the remaining groups ($p < 0.001$) (Figure 3). Bilberry coverage had also a significant relation to basal area ($r_s = 0.248$, $p <$

0.001), though not so strong. Bilberry weight after 5 minutes of cutting revealed no effect of maturity classes after controlling for the effect of basal area (ANCOVA $F(2,27) = 1.7353$, $p = 0.1954$), basal area did not have a significant effect on bilberry weight (ANCOVA $F(1,27) = 3.0730$, $p = 0.0909$). Temperature did not have a significant relation to bilberry coverage, neither average midday temperature ($F(1,50) = 0.0625$, $r^2 = 0.0012$, $p = 0.8035$) nor average midnight temperature ($F(1,50) = 0.9542$, $r^2 = 0.0187$, $p = 0.3334$). Bilberry weight and bilberry coverage had a significant correlation (Spearman $r_s = 0.629$, $p < 0.001$).

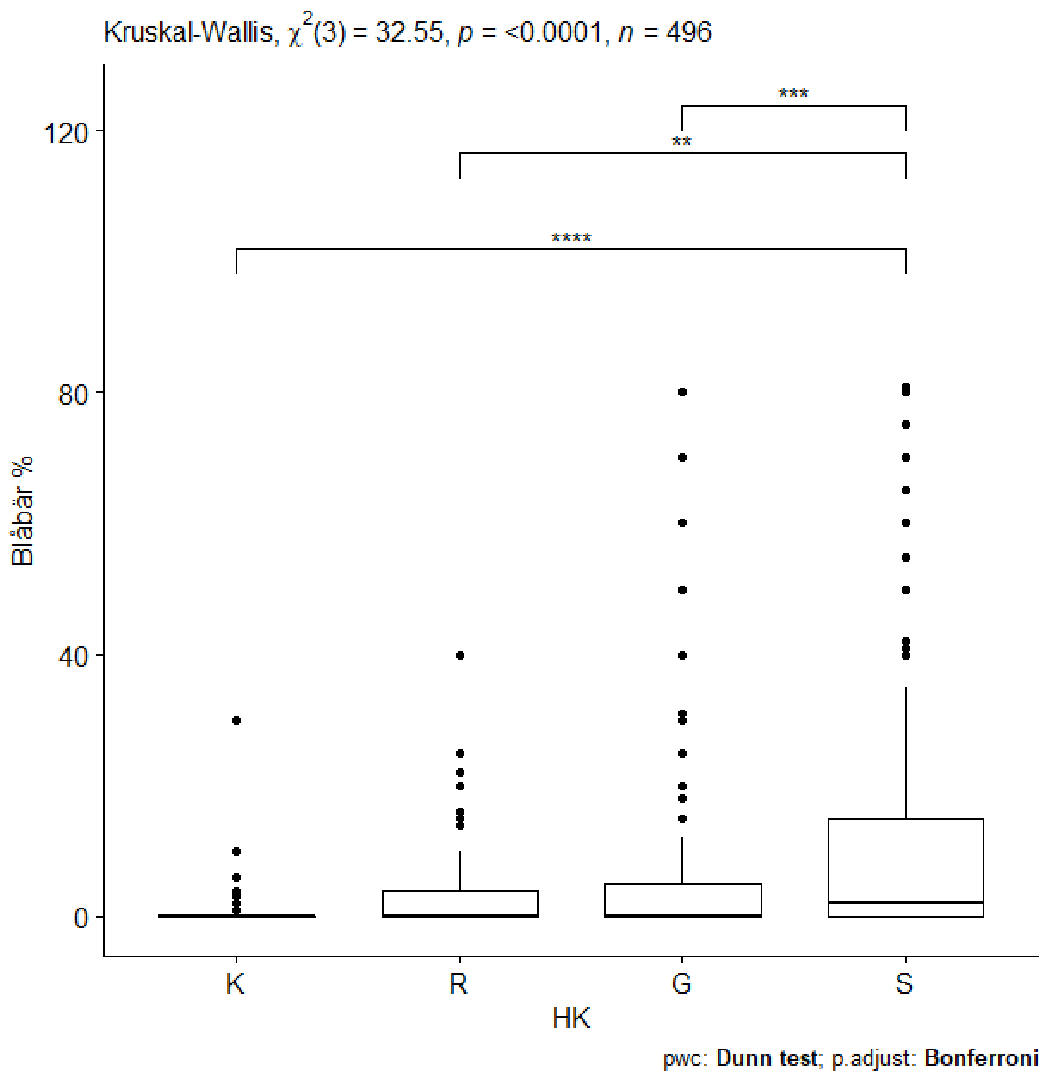

*Figure 3. Bilberry coverage's (Blåbär %) distribution in each maturity class (HK). The * indicates a significant difference between each group, more * suggests a greater difference.*

The bilberry quality was investigated through relative feed value and lignin percentage. Relative feed value had the highest average score in the maturity class thinning, 78.9, and most samples collected from the thinning class (Appendix 2). Lignin however, also had most samples from the thinning class (Appendix 2) but had the highest mean percentage value in the final harvest class, 31.3 %.

Relative feed value was uncorrelated to maturity classes after controlling for the effect of basal area (ANCOVA $F(2,29) = 0.5216$, $p = 0.5990$) and had no relation to basal area (ANCOVA $F(1,29) = 0.0289$, $p = 0.8663$). The relative feed value did not have a significant relation to bilberry weight either ($F(1,28) = 3.711$, $r^2 = 0.117$, $p = 0.0642$). Similar results could be seen with lignin, which was not effected by basal area (ANCOVA $F(1,29) = 0.3228$, $p = 0.5743$). Lignin did not a significant relation to maturity classes after controlling for the effect of basal area (ANCOVA $F(2,29) = 0.3305$, $p = 0.7212$). Lignin was not significantly related to bilberry weight either ($F(1,28) = 3.827$, $r^2 = 0.1202$, $p = 0.0605$).

4. Discussion

Older forest stands that have progressed further in the successional stages had an increased basal area. The temperature was lower in older forest stand during the day and slightly higher during night-time. A significant correlation was also found between average midday temperature and basal area, while the average midnight temperature had a significant effect of maturity classes. Bilberry coverage was marginally the most in final harvest forests and showed a significant relation with maturity classes. Bilberry weight was, also here, marginally heavier in final harvest forests but was not correlated to neither maturity classes nor basal area. Neither relative feed value nor lignin content percentage was correlated to maturity classes and was also not related to bilberry weight.

Basal area and maturity classes strong correlation seems adequate since a clear-felled area should have the lowest basal area while a forest ready for thinning or final harvest should have a greater basal area (Lundqvist et al. 2014; Agestam 2015). Another effect of maturity classes and/or basal area is on temperature. The temperature difference in each maturity class may be due to forested areas having less fluctuating temperature in contrast to non-forested areas (Häntzschel et al. 2005; Von Arx et al. 2012), for example after harvest.

Bilberry coverage was affected by maturity classes, with significant difference between final harvest and the other maturity classes (clear-felled areas, pre-commercial thinning, and thinning). The variables were not tested in an ANCOVA due to the assumption of homogeneity being violated, instead a Kruskal-Wallis test was applied. Neither of the midday nor midnight temperature affected the bilberry coverage, even though temperature is suggested to be important in bilberries phenological stages from budding, flowering and finally berry production (Selås 2000; Hertel et al. 2018). The difference of bilberry coverage between the maturity classes may be due to the differences in available light reaching the forest floor between each class (Mäkipää 1999). Bilberry thrives in semi-shaded areas and will decrease its distribution when the forest starts to close its canopy (Kardell 1979; Coudon and Grégout 2007; Kardell and Eriksson 2011; Eldegard et al. 2019), however, even well-managed forest may not completely close its canopy. Thinning is therefore an important silviculture practice since the procedure may reduce the number of tree stems between 20 – 40 %, in Swedish forestry (Agestam 2015), thus opening up the tree canopy and allowing an increased amount of light to hit the forest floor. The process of thinning may increase the amount of bilberry with 40 – 100 % (Tonteri et al. 2016), hence an important silviculture procedure for both tree growth and bilberry availability. While harvesting will substantially decrease the amount of bilberry (Kardell 1979; Atlegrim and Sjöberg 1996; Tonteri et al. 2016), the bilberries does not make a significant recovery until reaching the later successional maturity class again. Rotation period is therefore an important aspect, since a shorter rotation period would mean that bilberry may not have the time needed to reach full coverage (Hedwall et al. 2013). Recognizing bilberry's most suitable habitat projected to maturity classes may mitigate when determining the dwarf shrub's distribution. Thus, knowledge of the ideal maturity classes may help in preserving enough bilberry habitable landscape to ensure ungulate forage. Bilberry is an important staple food source for ungulate species in Sweden; moose, red deer, roe deer, and fallow deer (Barancekova et al. 2010; Krojerova-Prokesova et al. 2010; Obidizinki et al. 2013; Schrempp et al. 2019). Spitzer et al. (2021) explains that increased deer densities will drive moose towards consuming more pine, thus increasing damages on the tree species. By managing and promoting the dwarf shrub may mitigate pine damages, thus ensuring enough forage for a healthy moose population. Knowledge of bilberry distribution and its application on a larger scale, maturity classes, may also benefit the berry picking industry by alleviating the search of the dwarf shrub, thus increasing the effectiveness of the berry pickers.

Bilberry weight after 5 minutes of cutting had no effect of maturity classes. Bilberry weight had the lowest number of observations, which in turn may influence the results, and no observations in the pre-commercial thinning class. Even though bilberry weight and bilberry coverage had a positive relation were they not affected by the same factors. Bilberry weight may be affected by other factors, for example soil nutrition or grazing. In conjunction with bilberry coverage could a more precise measurement of the available forage be predicted, due to their positive correlation. This correlation seem fair since an increased amount of bilberry should equal more bilberry to collect, thus a larger amount in weight. The bilberry weight might give insight to how much, in weight, forage is available for all who consume the dwarf shrub (Selås et al. 2011; Hertel et al. 2016).

Bilberry quality was not affected by maturity classes nor bilberry weight, which may suggest that there are other factors influencing quality. Light, same as with the bilberry coverage, could be the underlying factor that affects quality as well, or even precipitation (Mäkipää 1999; Selås et al. 2011). Selås et al. 2011 discovered that bilberry quality was not related to bilberry production, which suggest that is would not have mattered when the bilberry samples were cut, thus excluding seasonal variables. However, a larger sample size may yield significant results since my results were nearly significant but had a rather small sample size. Bilberry quality and temperature was not tested due to the small sample size, there was no guarantee that bilberry would be available in plots with iButtons present.

An approach to involve and analyse more temperature data would be to extend the temperature data across several years. However, in this case it was not possible since that kind of data do not exist yet, but other kinds of temperature data could be applied, for instance satellite or weather station data. That could possibly yield insight to how bilberries' spread in response to temperature. Henceforth, predicting the amount of available forage for ungulates. Another facet to consider is in the collection method of the maturity classes. Maturity classes was observed for the first time this year, thus challenging the field technicians to accurately categorize the sampling plots. For example, to an untrained eye it may be difficult to distinguish a stand ready for thinning from a stand ready for harvest, or even when a stand is in-between maturity classes, especially when the age of the trees is unknown, which is important in the later successional maturity classes. Knowing the age of a stand is even of greater importance when pinpointing the correct subcategory, for example if a stand ready for thinning exceeds the age of final harvest (i.e., S2) or not (i.e., S1). To counteract, basal area was objectively measured and seizes the variables of interest. However, what is great about this dataset is that the same kind of data has been collected from this study area for many years now, and the field technicians have a system of how to equally collect the data to minimize any biases.

A limitation of this study is the small number of observations in the average temperature data, bilberry weight data and bilberry quality data, especially in the clear-felled and pre-commercial thinning groups. The observation's disproportionate distribution across classes may cause bias and yield unrepresentative outcomes. A larger sample size would counteract this, however, in this case were there no time nor resources to get a larger sample size. The iButtons were not always found where they were installed the previous year or just could not be used. The lost iButtons could have attracted animals, perhaps they were entranced by the glimmering plastic bags, so the bags were chewed or ripped of their original location, some iButtons were found with bitemarks on them. Other iButtons could not be used since there were too much water in the bags or were found on the ground, creating misleading data since water could be conducting towards warmer and/or colder temperatures. The iButtons found on the ground would give ground temperature data and not the air temperature. Not knowing when the bags filled with water or when the iButtons fell to the ground limits the data by not being able to exclude the temperature data after these occurrences. The small sample size of bilberry weight could also be solved by cutting and collecting more bilberry samples at more locations with iButtons. Due to the time limit and mostly me who cut the bilberries and weighed the samples in field, it was not possible to do it in a faster pace. It was also difficult to determine at which iButton locations bilberries would also be present, resulting in some days with a very low amount of bilberry samples collected. By next time could the field technicians installing the iButtons note of there was any available bilberries in the vicinity or place more field technicians out to also collect bilberry samples.

By taking the results and limitations in consideration, future studies could focus on other variables affecting bilberry coverage, bilberry weight as well as bilberry quality. For instance, light, which seem to have a central role in bilberry distribution, habitat, and quality (Mäkipää 1999; Eldegard et al. 2019). Or as previously mentioned, looking at temperature's effect on bilberry coverage over a longer time period to get insight of how bilberry coverage moves across the landscape and if global warming may have any effect on the dwarf shrubs distribution (Hallinger et al. 2010; Kardol et al. 2014). Site productivity (i.e., mean incremental growth over a defined interval) (Avery and Burkhart 2015) may be another interesting factor to consider when analysing bilberry weight and quality. Also, an additional interesting factor would be if the bilberries were grazed or not, and the intensity of the grazing damages. The results could give an understanding of how much ungulates or insect graze on the dwarf shrub, if there are other untouched location to compare with. Other studies have suggested that grazing intensity on bilberry is not correlated to bilberry quality (Van der Wal et al. 2000; Fernandez-Calvo and Obeso 2004), but future studies could investigate the effect grazing has on bilberry quality. There are many more aspects that could be taken into consideration when looking into bilberry availability, species composition and the interaction between variables.

To summarize this study, the results suggests that bilberry availability increases with time, which is coherent with other studies. Silviculture practices, along with longer rotation periods, affects the availability of bilberry to a greater extent than forage quality. This seemed not to be affected by temperature gradients, but rather the available light having a significant role. By being able to connect bilberry to suitable silviculture practices, which could increase the amount of available bilberry as forage, thus mitigating ungulated related forest damages.

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Appendix 1

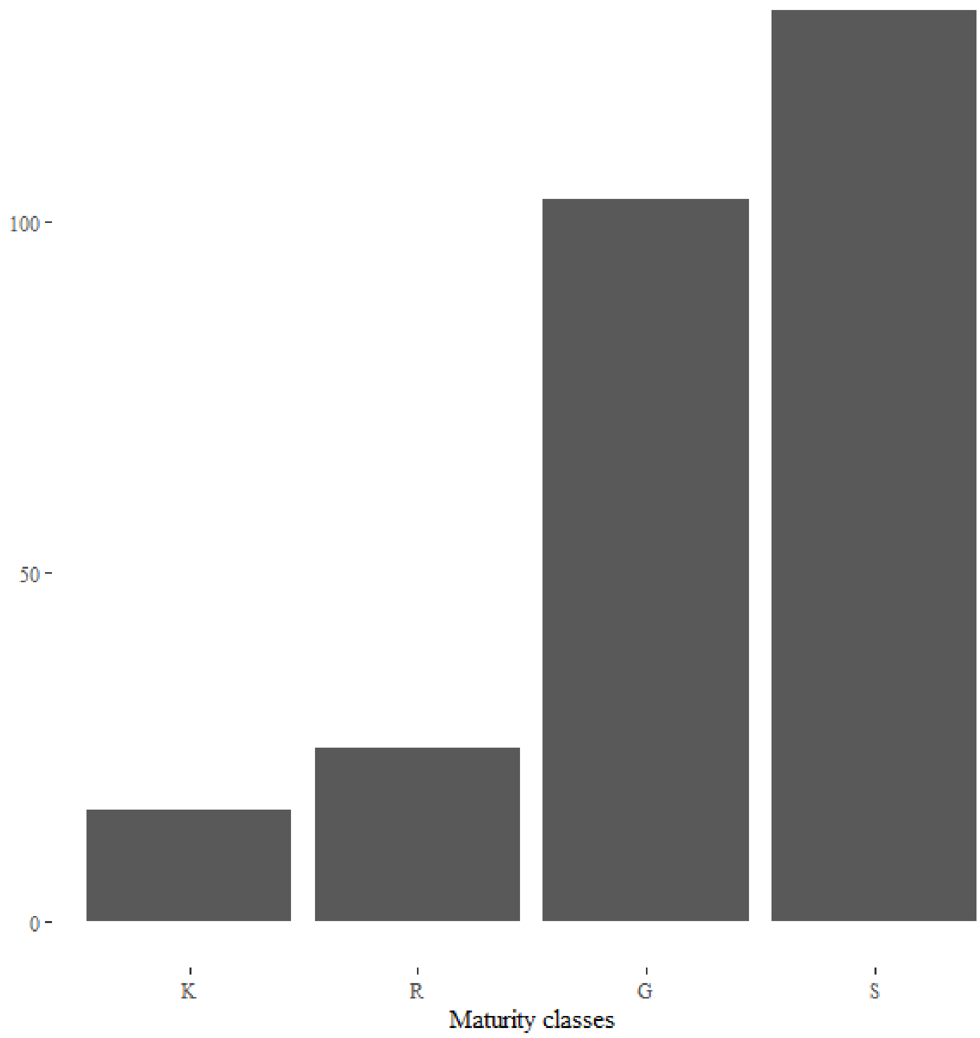

Figure A1. Number of bilberry coverage observations, when bilberry have been observed, in each maturity class. K stands for Clear-felled area, R for Pre-commercial thinning, G is Thinning, and S stands for Final harvest.

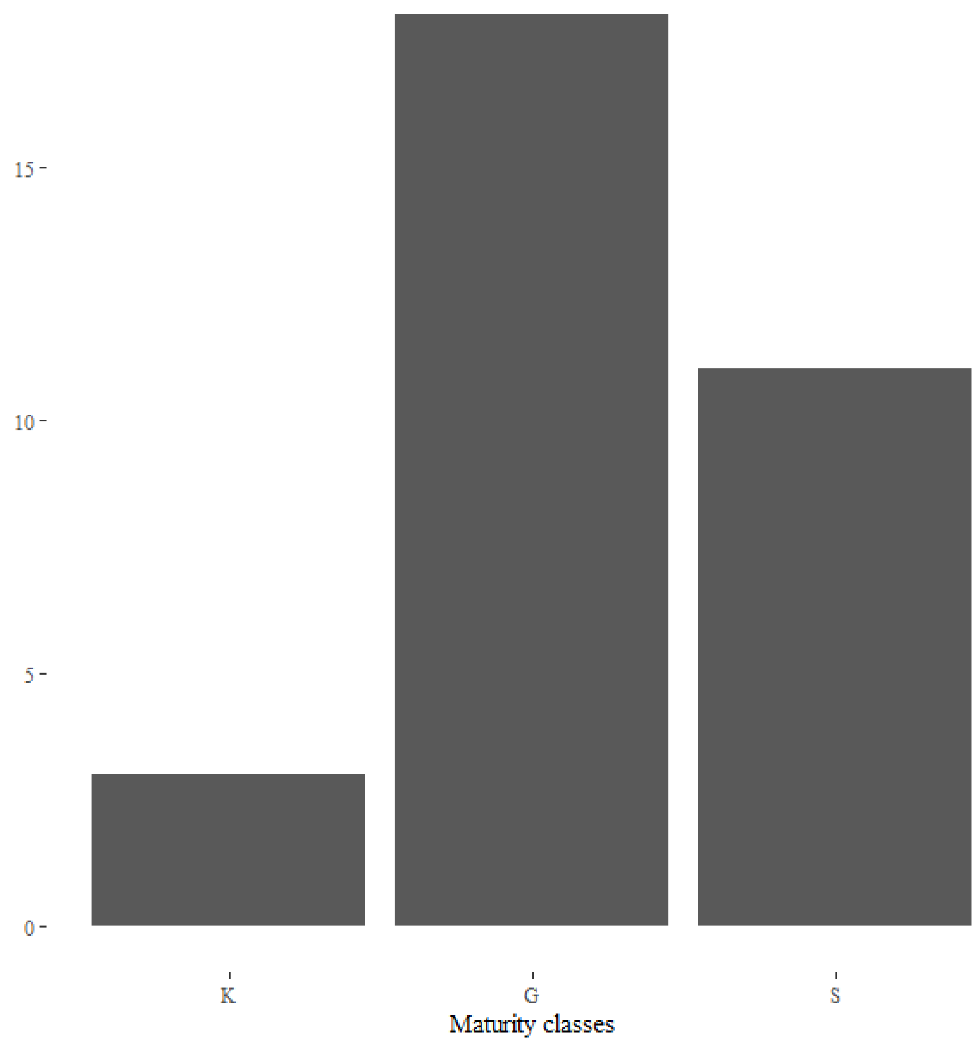

Figure A2. Number of bilberry weight observations, number of plots where bilberry have been cut during 5 minutes in a pace representing ungulates foraging, in each maturity class. K stands for Clear-felled area, R for Pre-commercial thinning, G is Thinning, and S stands for Final harvest.

5. Appendix 2

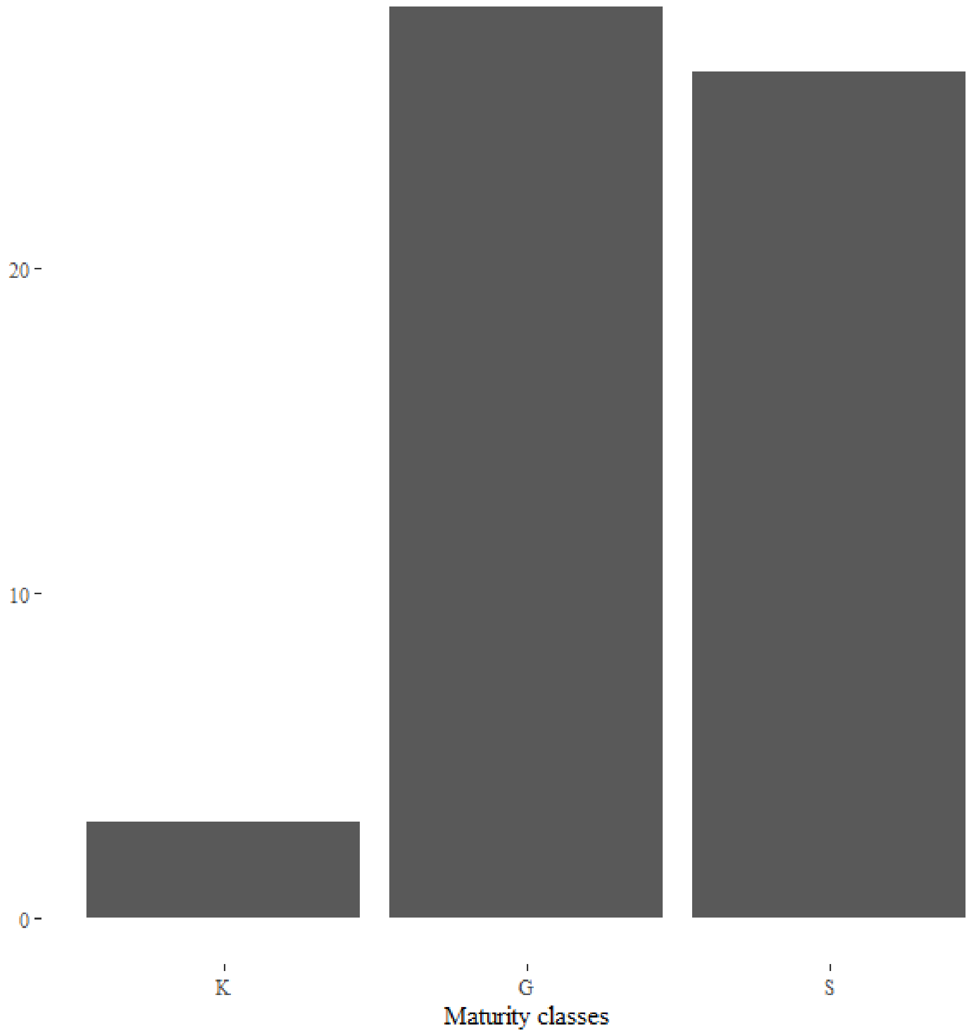

Figure A3. Number of relative feed value and lignin samples from each of respective maturity class. K stands for Clear-felled area, R for Pre-commercial thinning, G is Thinning, and S stands for Final harvest.