How do forest characteristics relate to brown bear (*Ursus arctos*) density?

Focusing on basal area, age, height, and field layer

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How do forest characteristics relate to brown bear (*Ursus arctos*) density? Focusing on basal area, age, height, and field layer

Hur förhåller sig brunbjörnens densitet till skogens karaktär?
Med fokus på grundytan, ålder, höjd och fältskikt

Jeanette Jonsson

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Abstract

Brown bear (*Ursus arctos*) is one of our most common large carnivores. The historic population in Sweden has been reduced due to conflicts with humans. The diet of the brown bear varies with the season and location. In the USA, brown bears feed more on salmon (*Salmo salar*) and trout (*Salmo trutta*), while in Sweden it is more reindeer (*Rangifer tarandus*) and moose (*Alces alces*) during the spring which interferes with reindeer husbandry. Bilberry (*Vaccinium myrtilus*), and lingonberry (*Vaccinium vitis ideae*) is the most important food resource during the late summer and fall, occasionally the bears also feed on ants. Bears occur in boreal forests and females select home ranges that provide good food resources. Before entering hibernation, bilberries are one of the most important food resources and are heavily affected by forest management, the thinning phase, and mature forests that are ready to be clear-cut. After a clear-cut, the bilberry is greatly decreased but starts to recover as the forest grows and the canopy closes. When the forest becomes too dense the bilberry stops growing but it starts to increase again after thinning. This study investigated how the forest characteristics are related to the bear density since the bilberry abundance changes during one management cycle of the forest and bilberry is one of the most important food recourses. Two linear mixed models (lme) were created with bear density as a response variable. Model one contained mean height, basal area, and age. The second model contained the seven groups of field layers (bilberry, lingonberry, poor, grass, herbs, crowberry, and no field layer) as explanatory variables. The bear density data was estimated from spatial capture-recapture surveys based on DNA from feces collected during fall, the forest data were obtained through the NFI (National Forest Inventory). The results show that age was positively correlated with the bear density. This could be since bilberry is heavily affected by clear-cutting and takes years to recover. The basal area and mean height, on the other hand, had a negative correlation with bear density. This could be since bilberry is favored by forests that are not too dense but have a basal area of around 30-40 m^2/ha and a canopy openness of 50%. Furthermore, both bilberry and lingonberry abundance peak at a lower forest height, bilberries around 15 meters and lingonberries around 0 meters. There was no difference between the field layers, except the *No field layer* which gave a lower bear density compared to bilberry.

Keywords: Brown bear, *Ursus arctos,* linear mixed model, forest characteristics, bear density

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Abbreviations

NFI	National Forest Inventories
NGS	Non-invasive Genetic Sampling

1. Introduction

Historically there have been conflicts between large carnivores and humans, this conflict caused high mortality in carnivore populations. There are still conflicts today that affect the abundance of carnivores, such as human densities and infrastructure (Morales-González et al. 2020). One of these large carnivores is the brown bear (*Ursus arctos*), where the population was reduced to only a few individuals during the 1900s (Kindberg et al. 2011). Since then, new management measures have been implemented and the brown bear population has increased in Sweden (Kindberg et al. 2011; Eriksson et al. 2015) and is today the most abundant large carnivore (Chapron et al. 2014). The diet of the brown bear varies with the location and season (Stenset et al. 2016). For example, the American brown bears feed on more fish species such as salmon (*Salmo salar*) and trout (*Salmo trutta*) (Colton et al. 2021), while in Sweden during the spring brown bears consume more moose calves (*Alces alces*) and reindeer calves (*Rangifer tarandus*) (Stenset et al. 2016). The predation on reindeer calves then interferes with reindeer husbandry and contributes to human-predator conflicts (Eriksson et al. 2015) and poses challenges for brown bear conservation (Chapron et al. 2014).

1.1 Brown bear and its ecology

Brown bears are apex predators and have no natural enemies (Hertel et al. 2016b). The brown bear occurs in boreal forests (Naturvårdsverket 2003) and prefers coniferous forests (Twynham et al. 2021), and forests that provide shelter (Penteriani & Melletti 2020). In 2020, brown bears were resident from the central parts of Sweden (Värmland) to the northern parts of the country (SLU artdatabanken 2020). Brown bears are long-lived and have a low reproduction rate (Kindberg et al. 2011). Furthermore, it appears that the bear density is influenced by food availability (Zedrosser et al. 2006), and female brown bears select home ranges with good food availability (Martin et al. 2010). Brown bears are omnivores and change their diet over the different seasons of the year and with food availability (Stenset et al. 2016). During spring and the calving season for moose and reindeer, calves are preferred over the adult moose or reindeer (Twynham et al. 2021). Bears also feed on ants on some occasions during the spring and summer

(Swenson et al. 1999). During the summer, July, bears have berries as their main food (Hertel et al. 2018), and berries are the most important food before hibernation (Hertel et al. 2016a, 2018). During hibernation, females have their cubs and it has been shown that during years with more berries the weight of cubs during the spring after is higher than in years with lower berry abundance (Hertel et al. 2018). Furthermore, areas with lower berry abundance create competition between the bears and could decrease their weight and reproductive success (Zedrosser et al. 2006). Berry abundance is heavily affected by forest management (Hertel et al. 2016a; Jonsson 2022), furthermore, forest management contributes to a more fragmented bear population (Nellemann et al. 2007).

1.2 Forest management in Sweden

The dominant forest management practice in Sweden is based on clear-cutting and has been used for the last 70 years (Albrektson et al. 2012). The forestry is adapted to be fast-growing (Hedwall et al. 2013) and provides wood material in form of for example, timber to the industry (Fridman et al. 2014). The management cycle is divided into four stages (Albrektson et al. 2012). Starting with the regeneration stage, then young forest, thinning forest, and lastly forests that are ready to be clear-cut (Albrektson et al. 2012). After a clear-cut, scarification of the soil is often done before planting to improve water flow and nutrition for the new young trees (Örlander et al. 1996), this management measure damages the roots of the bilberry plants, and their abundance is greatly reduced (Kardell & Eriksson 2011). The bilberry abundance is lower in younger stands than in mature forest stands (Eldegard et al. 2019). During the young forest stage, a pre-commercial thinning is often performed to remove competing trees and determine the final tree species composition (Albrektson et al. 2012; Pettersson et al. 2012). When the canopy is too closed not enough sun reaches the ground, and this reduces the production of berries (Kardell & Eriksson 2011). Furthermore, Hedwall et al. (2013) found that bilberry abundance decreased as forest volume increased (Hedwall et al. 2013). During a thinning, the outtake can be measured based on the harvested volume (around 30%) or basal area (around 20%) (Hedwall et al. 2013), which increases the amount of light that reaches the ground, and this leads to an increase in bilberry abundance (Kardell & Eriksson 2011). Previous studies have also shown that bilberry was favored in forests that are not too dense and had a mean height of around 15 meters, whereas lingonberry was favored in open forests and had a height close to 0 meters (Bohlin et al. 2021). Eldegard et al. (2019) found that the bilberry abundance peaked at a higher basal area in pine forests (the basal area around 30 – 40 m^2/ha) (Eldegard et al. 2019). When it comes to forest age, bilberries peak when the forest is between 80-100 years old (Hedwall et al. 2013).

The berry abundance changes between the different forest management stages and, as noted, is the most important food resource for the brown bears during the fall. Furthermore, female brown bears select areas with a high food abundance for their home range. It would therefore be interesting to see how the forest characteristics such as basal area, vegetation, etc., are related to bear density, and that is the aim of this study. I will assess the following questions:

- Is bear density higher in denser stands or open stands?
- How is the field layer related to bear density?
- Are there other forest parameters that can explain the bear density?

2. Method

2.1 Collecting bear data

Between the years 2012 and 2019, a dataset containing DNA samples from 2 824 bear individuals was collected (Bischof et al. 2020). In Sweden, the DNA samples are collected voluntarily by hunters and is done on county levels (Bischof et al. 2019). The DNA collection starts on August 21st and ends on October 31st and is collected by non-invasive genetic sampling (NGS) in the form of feces (Bischof et al. 2019). These data, which are sampled by NGS, are combined with DNA samples from recovered culled bears. The DNA samples are then analyzed to determine the sex and unique individuals. This is done by comparing genetic markers, one marker for sex and another eight markers to determine unique individuals (Bischof et al. 2019). The collected data were then analyzed by an open-population spatial capture-recapture (OPSCR) model. This was done mainly to estimate the density and population size of the brown bear. The model itself is based on three different models, one part of the model to estimate the population size, another to estimate the density and activity center, and the last part for individual detection (Bischof et al. 2019).

The population size depends on the mortality rate and bears that are alive from one year to another. In the end, the estimated population size is the number of individuals that are alive at the end of the year (Bischof et al. 2019). For the bear density, an analysis of the home range for different individuals describes the density within an area. Bear density can change over the years, due to emigration and immigration between areas (Bischof et al. 2019). The density analysis has a confidence interval of 95% and the results were summarized into seven rasters each representing one monitoring year reaching from 2012 to 2018 (Bischof et al. 2019).

2.2 Collecting forest data

The National Forest Inventory (NFI) started in 1923 and collected information regarding the forests and in 1929, this was done for the whole country (Fridman et al. 2014). From 1983 the information is collected from both permanent inventory plots and is complemented by random plots. The plots are inventoried every fifth year for the permanent plots and every year for the random plots (Fridman et al. 2014). The information collected is the age, the tree species composition, the field layer, the stand productivity, volume that is estimated by regression models, and the next planned management measure (Fridman et al. 2014). The forest stand measurements were done on sub-sample trees in both permanent and temporal plots, age is an exception and was only measured on the temporal plots. The basal area was determined based on the probability of the trees being included in the plot. Furthermore, depending on the basal area, there are limits on how many sub-sample trees are included, but at least one per plot, this inventory method was established in 2003 (Fridman et al. 2014). The collected information was later combined with data from remote sensing to create thematic maps over for example volume or height (Fridman et al. 2014).

The collected forest data included in this thesis were from Gävleborg, Dalarna, Värmland, Västernorrland, Jämtland and Västerbotten counties (Figure 1).

Figure 1: Map over the Swedish counties where the study area is marked. Copyright © Hans Högman 2020-07-03

2.3 Analysis

The bear density rasters (Bischof et al. 2020), were uploaded and the seven rasters were then unstacked so each raster could be analyzed separately. The NFI data regarding the forest features were spatially linked to the density raster, resulting in each inventory plot being given a bear density. The coordinate system of the NFI data was converted into the same coordinate system as the bear data. The bear data used in this study were for the years 2014, 2015, and 2017. Those years were chosen since they were based on the most recent inventories of bear densities in these counties. In 2014, the bear inventory took place in Västerbotten county and was combined with NFI data from the same county, where the NFI data spanned from 2003 to 2014. The same procedure was then done for the other bear density rasters as well but for the year 2015, the bear inventory was in Jämtland and Västernorrland county and for 2017 in Dalarna, Gävleborg, and Värmland county. The NFI data was limited to only using plots that occurred in forested areas and excluded plots that occurred in non-forested areas for example on mires.

Before creating the linear mixed models (lme), the forest parameters in the NFI data were checked for correlation: forest age, mean height, basal area, and field layer. Inventory plots that had forest stands with a height that was less than seven meters lacked a registered basal area. To allow the inclusion of these plots in the overall analysis, NA-values were assigned a basal area value of one. The field layer was divided into seven groups: 1) *Grass,* including field layer types with broadleaved grass, thinned leaved grass, and higher herbs, 2) *Poor*, including field layer types with lower herbs without berry shrubs and no berry shrubs, 3) *Bilberry* including field layer types of higher herbs with bilberry, bilberry and lower herbs with bilberry, 4) *Lingonberry,* including field layer types of higher herbs with lingonberry, lingonberry, and lower herbs with lingonberry, 5) *Herbs*, including field layer types of higher herbs without berry shrubs and horsetail, 6) *Crowberry,* including crowberry types and 7) *No field layer,* as those who lacked a field layer for example lichens. The response variable (bear density) was transformed by cube-root transformation. The field layer classes are hereafter referred to as *Grass, Poor, Bilberry, Lingonberry, Herbs, Crowberry,* and *No field layer*.

Two models were created to address my three study questions, one model including the field layer classes only and the second one including a set of forest parameters (e.g., age, basal area, mean height, Table 1). The other parameters included in the second model were chosen due to their expected relevance to explaining bear density next to the attributes related to the field layer. For example, as a proxy for forest density and openness, I included the forest stand´s basal area in my analysis, because a denser forest has a higher basal area. Furthermore, the basal area could affect bilberry production and therefore correlate with bear density (Eldegard et al. 2019). Previous studies have also shown that the age of the forest is associated with bilberry occurrence (Hedwall et al. 2013). The mean height was included in the model since previous studies found that a mean height of approximately 15 meters gave the highest bilberry abundance and close to 0 meters had the highest lingonberry yield. (Bohlin et al. 2021).

Table 1: The two Linear mixed models (lme) that were created to test how the fixed effects correlate with brown bear density. Plot ID is assigned as random effects.

Model number	**Fixed effects**	**Data**
1	bearD ~ field_layer[a]	All data
2	bearD ~ Age[b] + Mean_height[c] + Basal_area[d]	All data

[a]Field layer in the forest stand

[b]Age of the forest stand

[c]Mean height of the forest stand

[d]Basal area of the forest stand

All spatial and statistical analyses were done in Rstudio version 2021.09.1. The results were considered significant within a 95% confidence interval. The field layer bilberry was used as an intercept for the first model, including only field layers.

3. Results

My results suggest that bear density is differently correlated to field layer and other forest parameters such as basal area, mean height, and forest age. The age of the forest correlated positively with bear density, while both the mean height and basal area correlated negatively with bear density. For the field layer classes, *No field layer* correlated negatively with bear density.

None of the forest parameters (basal area, mean height, age, and field layer) were correlated by more than 0.72 to each other.

3.1 Does the field layer affect the bear density?

Compared to the field layer bilberry, none of the field layers was correlated with significantly higher brown bear density (Table 2). On the other hand, the class *No field layer* correlated with a significantly lower bear density. Suggesting that the bear density could be affected in forests where a field layer is lacking.

Table 2: Statistical results containing the coefficients. The standard error (SE), t-value, and p-value given by the linear mixed model to describe how the brown bear density changes depending on the field layer in central and northern Sweden (bear density data for the years 2014 Västerbotten county, 2015 Jämtland, and Västernorrland counties and 2017 Dalarna, Gävleborg, and Värmland counties). The field layer class bilberry as intercept. The analysis included forested areas within the same counties as the bear density data and reached from the year 2003 until 2014. The analysis included a total of 11 525 plots. Significant difference in bold and 0.00 = < 0.0001

Field layer classes	**Coefficient**	**SE**	**t-value**	**p-value**
Poor	0.00	0.00	0.3	0.8
Grass	-0.00	0.00	-1.5	0.1
Lingonberry	0.00	0.00	1.6	0.1
Herbs	-0.00	0.00	-1.5	0.2
Crowberry	0.00	0.00	0.8	0.4
No field layer	-6.7e-03	0.00	-2.2	**0.00**

3.2 How do other forest parameters and stand openness affect bear density?

My results suggest that bear density also correlates with different forest parameters. Forest age correlated with an increased bear density. Bear density increased as the age increased (Table 3, Figure 2). On the other hand, the mean height and basal area of the forest correlated negatively with bear density (Table 3, Figure 2).

Table 3: Statistical results containing the coefficients. The standard error (SE), t-value, and p-value given by the linear mixed model to describe how brown bear density was related to forest height, age, and basal area in central and northern Sweden (bear density data for the years 2014 Västerbotten county, 2015 Jämtland and Västernorrland counties and 2017 Dalarna, Gävleborg, and Värmland counties). The analysis included forested areas within the same counties as the bear density data and reached from the year 2003 until 2014. Significant difference in bold and 0.00 = < 0.0001

Forest Parameters	**Coefficient**	**SE**	**t-value**	**p-value**
Mean height	-1.5e-04	0.00	6.3	**0.00**
Age	3.6e-05	0.00	2.1	**0.00**
Basal area	-3.3e-05	0.00	-1.6	**0.00**

Representing the mean height age and basal area of the forest stands.

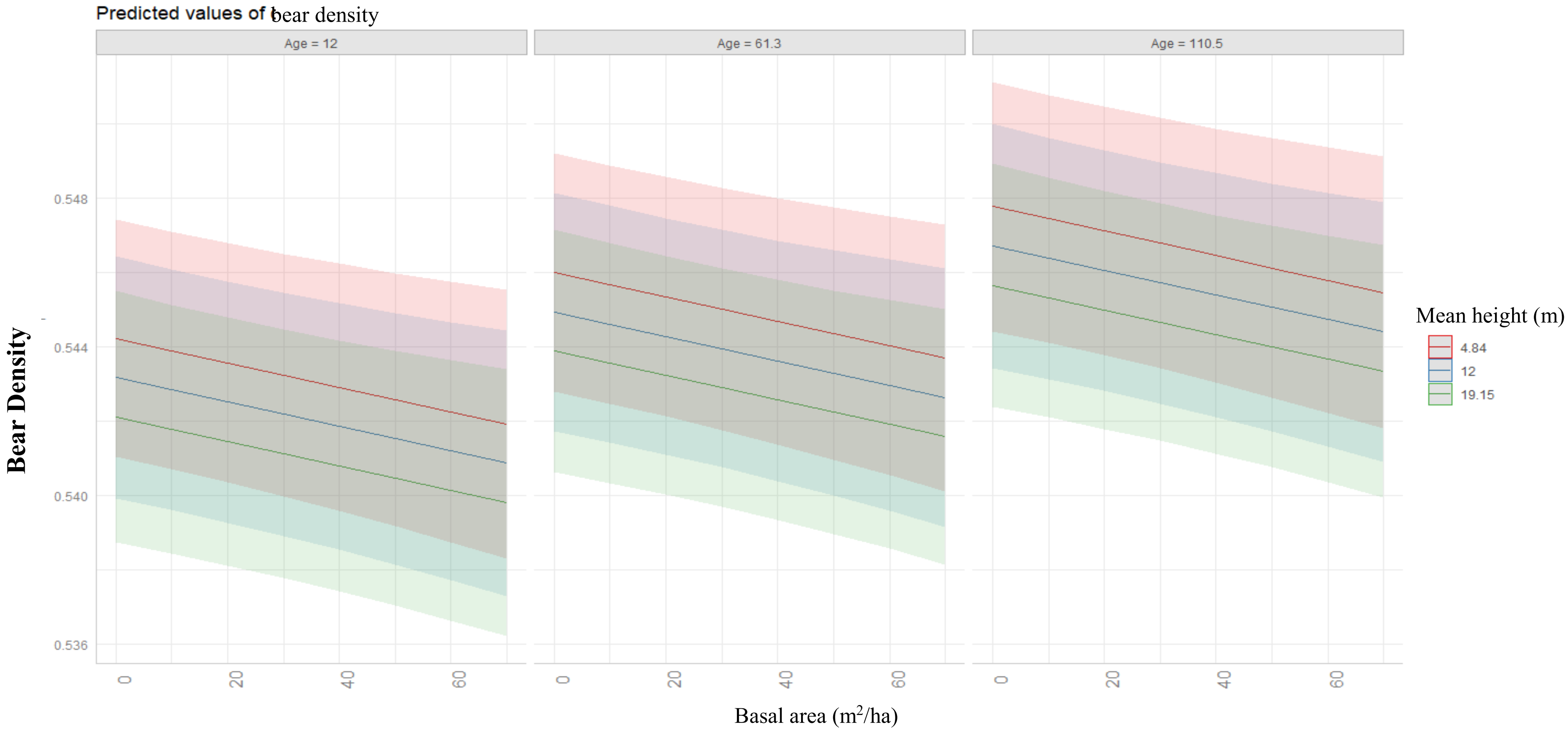

*Figure 2: Statistical results that are given by the linear mixed model (lme) on how the bear density correlates with forest basal area, mean height, and age, showing the **predicted bear density** (y-axis) depending on the age that is divided into **three groups** representing the ages 12, 61.3, and 110.5 years old. Within each age group the basal area is divided into four groups (0 m^2/ha, 20 m^2/ha, 40 m^2, and 60m^2/ha), and the mean height where 4.84 meters is in red, 12 meters is in blue and 19.15 meters in green. The figure shows that the forest age has a positive correlation with bear density, while mean height and basal area have a negative correlation with predicted bear density.*

4. Discussion

I found that brown bears' densities correlated differently with the characteristics of the forest caused by forest measures. According to the results, there were changes in the bear density that could be because of tree mean height, age of the forest, basal area, and the composition of the field layer. Forest management measures affect the field layer, which is important for the main food resources during the fall, bilberry, and lingonberry.

For the different field layers, my result suggests that there was an equal response for some of the field layers including berries, herbs, and grasses, on the other hand the *No field layer* class correlated negatively with bear density (Table 2), which could reflect a lack of food. Brown bears have berries as their main food resource during the fall before entering hibernation (Hertel et al. 2018). This could explain why there was no difference between forests with field layers dominated by berries, because bilberry, lingonberry, and crowberry are the most important food resource during this period, and depending on species abundance in a given year, utilization of a given berry species can change (Stenset et al. 2016). My result suggests that the vegetation class *no field layer* correlated with a lower bear density compared to *bilberry* (Table 2). The field layer class *no field layer* indicates a lack of vegetation in form of, for example, berry shrubs or grass and therefore might not provide important food resources during the fall for the bears, resulting in a lower bear density. In this analysis, the different field layers are compared to the bilberry field layer, but more food resources are important for the brown bear during fall (e.g., lingonberries and crowberries), which could affect my results. Stenset et.al (2016) found that bilberries were the berry that was most preferred by the brown bear, crowberries were the second preferred while lingonberry was the least preferred berry type (Stenset et al. 2016). One other factor that could affect the field layer is forest management, for example, after a clear-cut, bilberry decreases due to damages to the roots (Kardell & Eriksson 2011). If the forest is younger, it could be that the bilberry has not yet recovered and does not provide as much food as an older forest, so this could mean that the older forest could be preferred over the younger. After a clear-cut, the bilberry starts to recover when the canopy starts to close, and bilberry increases until the canopy becomes too dense (Kardell & Eriksson 2011).

The intensified forest management in Sweden led to an increased basal area, the bilberry field layer has decreased over time (Hedwall et al. 2013). Supporting my results that the bear density decreases with an increased basal area of the forest stands (Table 3, Figure 2). This indicates that different forestry measures may influence the bear density, for example after a thinning, as this measure decreases the average basal area in a forest stand. During a thinning around 20% of the basal area or 30% of the volume is taken out (Hedwall et al. 2013), which opens up the forests and increases the light on the ground (Kardell & Eriksson 2011).

Bilberry abundance is heavily affected by forestry measures, especially after a clear-cut, which can lead to root damage of the bilberry plants (Kardell & Eriksson 2011). The bilberry abundance then starts to recover as the canopy starts to close (Kardell & Eriksson 2011), the bilberry abundance is higher in mature forests compared to younger forests (Hedwall et al. 2013). The female bears select their home range in areas with a chance for food resources (Martin et al. 2010), which could explain the higher bear density in the more mature forest compared to the younger forest during the fall when bears forage mainly on berries and mature forests have a higher berry abundance. During the spring, on the other hand, bear feed more on moose and reindeer calves (Twynham et al. 2021), and the home range selected by the females might differ.

Since brown bears prefer forests that provide good shelter (Penteriani & Melletti 2020), forests with a higher basal area (i.e. more mature forests) should be preferred over forests with lower basal area by the bears. Yet, according to the results (Table 3, Figure 2), the brown bear density was lower in forest stands with a higher basal area. This could be due to the basal area in forest stands with a height below seven meters were not registered and were therefore assigned the basal area of 1 m^2/ha to allow these stands to be included in the analysis. To help diameter growth and to avoid a slower growth of the trees, a pre-commercial thinning is usually done before a height of seven meters (Pettersson et al. 2012). The forests that were given the value of 1 m^2/ha might not have been pre-commercial thinned and be denser and provide more shelter and therefore are preferred by the brown bear. Furthermore, these forest stands might not provide the same amount of food compared to a more open stand, suggesting that those forests might be avoided by the bears. Eldegard et al. (2019) found that the bilberry production in pine forests peaked at a basal area around 30-40 m^2/ha (Eldegard et al. 2019). After a thinning, the basal area decreases, and the forest becomes more open (Albrektson et al. 2012). Kardell & Eriksson et al. (2011) found that the increased amount of light that reached the ground after a thinning caused the bilberry to increase (Kardell & Eriksson 2011), which would mean more food for the bears and could increase their density. Bohlin et al. (2021) found bilberry is most abundant in forests with a canopy that is around

50% closed (Bohlin et al. 2021). This could be why my results suggest a higher bear density at lower basal areas because a thinning might have occurred that leaves the forest with a lower basal area and more food for the bears.

For the other forest parameters, my results suggest that there was a higher brown bear density in older forests, indicating that during the fall, bears may utilize older forests. The increased density of bears in the older forests could be an effect of increased berry production, since mature forests have more bilberry, compared to younger forests (Hedwall et al. 2013). It could be because right after a clear-cut and during the first years after, the bilberry is heavily damaged due to forest management practices (Kardell & Eriksson 2011). As the canopy closes the bilberry starts to recover (Kardell & Eriksson 2011). Next to a correlation with forest age, I found that the bear density decreases as the forest height increases (Table 3, Figure 2). This could be because the bilberry abundance peaked at a forest height of 15m and lingonberries closer to 0 meters. (Bohlin et al. 2021). This suggests that forests of lower height may provide more food for the bears.

Previous studies found that bears selected for younger stands during some periods, during the night, in the fall. On the other hand, during the day, during the fall, bears selected older forests (Jonsson 2022). In my study, I found that there was a positive correlation between older forests and bear density during the fall, which is in line with the other study. In another study in Western Alberta, the authors found that bears selected for younger and middle-aged forests (7-10 years old and 30 -40 years old) significantly less (Colton et al. 2021). In my study, I did not divide the age into different age groups, but my results show a similar trend. This could be due to more food in the mature forests (Hertel et al. 2016a; Eldegard et al. 2019)

<u>Limitations</u>

One of the difficulties with this analysis was when creating the model, to identify the repeated taxation plots and use them as the repeated factor in the mixed model. This could mean that some of the plots should be classed as repeated but are not repeated and vice versa. Meaning there could be a higher or lower number of repeated plots than used in the model. The bear data were collected during the fall, and the results could be different if the bear data were collected in the spring. Since during the spring, other food resources are used by the brown bear, such as moose and reindeer calves (Twynham et al. 2021). Another factor that could have affected the results is other disturbances that were not measured in this study such as human presence, or if the plots are closer or further away from human settlements or roads. There have been studies done regarding human presence and the response of the brown bear which suggests that the brown bear avoids areas where humans are present (Martin et al. 2010; Jonsson 2022). A previous study suggests that bears would select other habitats than what they usually do due to human presence in the form of, for example, bear hunting or moose hunting and berry picking (Jonsson 2022).

Future perspectives

It would be interesting to further investigate how other parameters such as latitude affect the bear density. A previous study found that the diet differed across biomes such as boreal and temperate forests (Bojarska & Selva 2012). Bears usually try to avoid human interactions (Hertel et al. 2016b), it would be interesting to further investigate how they are affected by infrastructure and human settlements. My study can help in conservation purposes for the brown bear since it can help provide information regarding the status of managed forests that are more preferred by the brown bear.

5. Conclusion

There was evidence that the forest characteristics and management measures were related to brown bear density. Age was positively correlated with a higher brown bear density. The height and the basal area on the other hand correlated with a higher bear density as the basal area or height decreased, suggesting that brown bears preferred more open forests and lower forests. For the field layers, there were no differences among field layer types with an exception for *No field layer* that correlated with a lower bear density compared to *Bilberry*. Thus, bear density could be affected by different forest management measures that change the forest characteristics through for example thinning or clear-cut, which in turn affect the food availability for bears in Swedish forests.

My study could help to establish suitable habitats for brown bears during the fall. The results could support conservation measures for the brown bear through adaptive forest management that provides these habitats.

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Popular science summary

Brun björnen (*Ursus arctos*) är en av våra mest vanliga rovdjur. Historiskt har björnpopulationen i Sverige minskat på grund av konflikter med människor, men med hjälp av nya förvaltnings metoder har björnstammen idag ökat (Kindberg et al. 2011). Björnarnas diet varierar beroende på tid på året men även på vilket område de befinner sig. I USA äter björnarna mer lax (*Salmo salar*) och öring (*Salmo trutta*) (Colton et al. 2021), medan i Sverige äter de mer renkalvar (*Rangifer tarandus*) och älgkalvar (*Alces alces*) under våren, vilket påverkar rennäringen (Stenset et al. 2016). Under våren kan björnarna ibland även äta myror. Blåbär (*Vaccinium myrtillus*) och lingon (*Vaccinium vitis ideae*) är de viktigaste födotillgången under sensommaren och hösten. Björnarna förekommer i den boreala skogen och honorna väljer deras hemområde där det finns god födotillgång (Martin et al. 2010). Blåbär, som är en av de viktigaste födoresurserna innan björnarna går i ide, påverkas kraftigt av skogsbruket. Skogsbruket i Sverige är uppdelat i fyra faser, föryngringsfasen, ungskogsfasen, gallringsfasen samt slutavverkningsfasen (Albrektson et al. 2012). Under en slutavverkning minskar blåbärens förekomst kraftigt, men börjar återhämta sig då skogen börjar växa och trädkronan sluter sig. När skogen blir för tät, stannar blåbärens återhämtning för att sedan börja igen efter en gallring (Kardell & Eriksson 2011). Undersökningen gick ut på att se hur skogens karaktär förhåller sig till björndensiteten, eftersom blåbärsförekomsten ändras under de olika skogsfaserna och är en av de viktigaste födoresurserna under hösten.

Det skapades två linjära modeller för att undersöka hur de skogliga karaktärsdragen höjd, ålder, grundyta och fältskikt förhöll sig till björndensiteten. Den första modellen innehöll skogshöjden, grundytan och åldern på skogen, medan den andra modellen innehöll sju olika typer av fältskikt (blåbär, lingon, fattig, gräs, örter, kråkbär och utan fältskikt). Datat kring björndensiteten samlades in genom DNA prov från bland annat björnjakt samt avföringsprov som samlas in under hösten (Bischof et al. 2019). Det skogliga datat samlades in genom inventering av Riksskogstaxeringen, där ålder, grundyta och höjd samlas in på permanenta och slumpmässigt utlagda provytor över hela landet (Fridman et al. 2014). Resultatet, visade att ålder hade en positiv korrelation med björndensiteten, högre densitet i äldre skog jämfört med yngre skog. Detta kan bero på att blåbär påverkas kraftigt av avverkningar och återhämtar sig då skogen blir äldre (Kardell & Eriksson 2011). Grundytan och höjden hade en negativ korrelation till björndensiteten, lägre densitet i tätare skog jämfört med glesare skog, samt lägre densitet i högre skog jämfört med lägre skog. Detta kan bero på att blåbärs förekomsten är som högst i en grundyta mellan 30–40 m^2/ha. Den negativa korrelationen med höjden kan bero på att blåbärs förekomsten är som högst i skog som är 15m hög och för lingon vid 0m hög (Bohlin et al. 2021), och att lägre skogar då har en högre förekomst av föda. Det var ingen skillnad mellan de olika fältskikten med undantag för *Utan fältskikt* som hade en negativ korrelation med björndensiteten jämfört med blåbär.

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