Skogssällskapet

Slutrapport

Projektrubrik: Risk of bark beetle damage in relation to forest management practice

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Populärvetenskaplig sammanfattning

More diverse forests have been found to strengthen the provision of multiple ecosystem services. A longstanding hypothesis in ecology when it comes to predator – prey interactions is that if the vegetation diversifies cascading up to the predator diversity resulting in higher predation pressure. Recent studies have shown that indeed predator diversity does increase with increasing tree diversity. However, this does not automatically translate into higher predation rates. In both agricultural and forestry systems the relationship between vegetation diversity and predation pressure is context dependent. Diversification is not only achieved through increasing tree diversity, for example structural diversity provided by tree of different age classes could provide a similar increase in predator diversity. In managed forest this could mean that increasing vegetation diversity and structural diversity could benefit the natural control of pest insect populations. Changing from monoculture-rotation forestry to mixed and or uneven aged forests is thought forest with intact ecological interactions, resulting in overall more stable forest ecosystems. Here, we use observational comparisons between mixed even-age stands, monoculture even-age stands, and monoculture uneven-age stands. The observational studies employ window-traps and malaise-traps to assess the arthropod diversity in stands of each type. We have used an experimental setup to assess the differences in predation rates between mixed and monocultures stands using spruce barkbeetle inoculated spruce stem sections. For the continuous cover forests data collection, we used experimental forest stands with nine locations and three treatments at each location. For the mixed forest experiment we selected stands owned by Sveaskog where the spruce trees had an average diameter +20cm. For the observational study investigation arthropod diversity we set up one malaise trap and two window traps (Figure 1A) in the replicate of each treatment of both the mixed forest and the continuous cover forest stands. For an additional measure of activity we used pheromone baited funneltraps and placed two in mixed stands and one in monoculture stands. In mixed stands funnel traps were place in an area dominated by spruce and where spruce was mixed with deciduous trees. The monoculture received two stem sections, one covered to prevent enemy attack and one exposed. The mixed stands received 3 stem sections. The stem sections were placed out near the locations of the funnel traps after the funnel traps had been deactivated (Figure 1B). Overall we found more spruce bark activity in monocultures compared to mixed stands (window traps). We find a higher biomass of the samples caught in control stands compared to the even-aged and selective cutting stands and no difference between the mixed and monocultures in biomass (malaise trap catch). The enemy activity was marginally higher in mixed stands compared to monoculture stands.

Resultat

Statistical methods

First, we analysed the differences in biomass between treatment within the different forest management method. We used generalised linear models to compare the means of the treatments. Second, we checked how successful the stem section treatment was by comparing the emergence rate of spruce bark beetle from the exposed and the covered logs using a paired t-test. We also compared the additional attacks by other bark beetle species on the stem sections between covered and exposed stem sections. Further we analysed the differences between the mixed and monocultures for the emergence of natural enemies using generalised linear modelling. As a continuous blocking factor we included the number of other bark beetles emerged in the analyses. We included the identity of the tree from which the stem sections originated as a random factor as well as the pairs of stands and the different locations.

Results

We compared the number of spruce barkbeetle individuals caught in window traps for the different treatment for the mixed forest and continuous cover forest data collection. More individuals were caught in mixed stands compared to pure stands (Figure 2A). Fewer individuals were caught in the control and the even-aged stands compared to the single tree selection treatment (Figure 2B). Comparison of the average biomass caught in malaise traps, shows no difference between the mixed stands and the pure stands (Figure 3A) but the control in the continuous cover set-up shows lower biomass in the catch compared to even-aged and selective cutting stands (Figure 3B).

The enemy study showed that in a pairwise comparison the covered trees indeed had significantly higher numbers of spruce barkbeetle individuals emerging compared to the exposed trees (paired t-test, $p=0.002$). The emergence of other barkbeetle species was significantly lower from the covered trees compared the exposed trees (paired t-test, $p=0.002$).

We compared natural enemy emergence from the inoculated stem sections for the different stem sections place out in the monocultures and mixed stands (treatment with 3 levels: pure stands, pure area in mixed stands and mixed area in mixed stand). We found that the pure area in mixed stands was significantly different from the monocultures, higher enemy emergence, but the monoculture was not different from the mixed forest and the pure area in mixed stands was not different from the mixed stands ($X2=6.43$, $df=2$, $p=0.04$; Figure 4A). If we compare the mixed and pure stands (treatment with two levels: pure stands, mixed stands) then we see that the average emergence of natural enemies is higher in mixed stands ($X2=5.21$, $df=1$, $p=0.02$; Figure 4B).

Målbeskrivning

The project has partially achieved the goals. We set out to compare pure stands to stands with alternative management for the activity of spruce bark beetle and natural enemy pressure. We have achieved the first part for both the mixed and the continuous forest set-up. To assess the natural enemy pressure, we successfully did this for the mixed stand set-up. The methods were employed successfully and we can based on the results answer the research questions and address the expentations. In the original research design we had planned to replicate the total experiment in three types of forest stands, pure spruce even-aged, pure spruce uneven-age and mixed stands (even aged). However, due to the lack of availability of the different treatments, we had to resort to setting up the experiment between pure stands and mixed stands and separately investigate the continuous cover component of the research.

We chose then to use more generic trapping methods to assess spruce bark beetle activity and arthropod diversity in the mixed setup and the continuous cover set up. Even though we cannot do one-on-one comparisons that we can compare the difference with the pure even-aged spruce stands in both set-ups. However, a quantitative comparison not possible. Because of changes to the project participant composition over time we have had to extend the project time lime. Also, we are still working with samples taken in 2021 as the sampling was extremely intensive. However, the first results paper can be written based on the result presented in the report. As this is one of the first studies experimentally investigating the effects of tree diversity on predation rates of spruce bark beetle in mixed and monoculture stands, the results are expected to be of wide interest.

Kommunikation och nyttiggörande av resultat

At least two research papers can result from this project. The first article will discuss spruce barkbeetle and natural enemy responses to forest management. The second will discuss the biodiversity aspects of different forest management methods. The first two articles will be using a strong ecological background and will be submitted to more generic scientific ecological journals. The third research paper will focus on the management implications of the results and will take a more practical approach to the results. This latter article will be submitted to a forestry journal and rewritten for popular science publication. Participation of the main applicant in the forest damage center as analyst for forest entomology provides excellent opportunity to disseminate the results to stakeholders via the forestry press (press release) and via direct meetings with the stakeholders. Also opportunities to orally communicate the results will be used. For example, Friday 9 February 2024 a presentation will be given for employees of Upplands Länstyrelsen to inform them about spruce barkbeetle and forest management.

Bilaga till slutrapport

Bilaga 1