The influence of post-fire salvage logging on soil-dwelling arthropods and implications on biodiversity conservation

Thesis

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Abstract
In many ecological systems, fire, either natural or anthropogenic in origin, is considered to be one of the most widespread forms of disturbance. A common silvicultural practice performed after a fire includes the removal of burnt woody material from burnt sites, also known as “salvage logging”. This form of logging is highly controversial due to its negative environmental effects, amongst them on the forest floor system. This study tries to shed light on the influence of fire and post-fire salvage logging on soil dwelling arthropods (macro and meso- fauna). In addition, due to the substantial effects of fire on the physical properties of the

above ground soil habitat, a question arose, concerning the efficacy of common methods of sampling soil fauna under these effects, and whether it is feasible to use these methods while comparing arthropod communities in the different post fire habitats. This study examines the following questions specifically:

- Is the commonly used method of sampling ground dwelling fauna- pitfall trapping- equally efficient in structurally variable habitats?
- What are the influences of fire and post fire logging on the abundance, richness, diversity and composition of the above and below ground arthropod community?
- Which environmental properties are most influential on arthropods inhabiting the forest floor?

During the 2006 conflict in southern Lebanon, 1200 ha of planted conifer forests were burned, among them 160 ha in Birya forest, where the study was conducted. In order to answer the above mentioned first question an experiment was conducted to examine the efficiency and rate of capture of arthropods using pitfall traps. The experimental setup included 8 enclosures which were erected in two structurally variant habitats. Each enclosure was populated with a set number of Arachnids and beetles, after which a three day observation of pitfall capture rate took place. The experiment was conducted in two repetitions. No significant differences in capture rate or efficiency between the two habitats for both taxa were observed.

The bulk of the study was conducted in eleven plots, representing three plot types: 1) burnt-logged plots: intensive disturbance (4 plots in total); 2) burnt-not logged plots (including live stands): intermediate disturbance (3 plots in total); and 3) undisturbed control plots of mature forest (4 plots in total). Five field sampling sessions were conducted throughout one year, during which above and below ground fauna was sampled by pitfall trapping and soil coring. In addition, chemical and physical soil properties, as well as floral properties, including species richness, percent coverage and habitat heterogeneity indices, were used for characterization of the three habitats.

The soil fauna was sorted into five main taxonomic groups: Coleoptera, Myriapoda, Collembola, Formicidae, Arachnida. Taxonomic identification was performed for Coleoptera and Myriapoda. The Collembola were sorted to four morphologic-functional groups. Our results show that the burnt plots possess higher floral richness, with a slight superiority of the burnt-logged plots. However, the burnt-not logged plots were found to be more structurally diverse. Regarding community composition, the implementation of post fire logging was found to be more influential compared to no post fire action. Namely, logging is a sterner disturbance, with a stronger influence on the habitat; following this are more significant influences on the community composition.

In the plots where post fire logging had taken place, the most significant factors influencing arthropod composition are related to seasonality and physical properties of the habitat pursuant to the fire. While examining seasonal trends in Coleopteran richness and abundance, an interaction between season and habitat was observed. Excluding summer, coleopteran richness and abundance was higher in burnt plots compared to control plots. Coleopteran species composition was found to be different in each habitat regarding incidence of dominant species and segmentation to functional groups.

Myriapoda abundance, richness and diversity were higher in control compared to burnt plots. Comparing both silvicultural strategies, the burnt-logged plots supported higher abundance whilst the burnt-not logged plots had higher species richness and diversity. On a seasonal aspect, the Myriapoda richness and abundance indexes' response was uniform in all treatments, with a low during summer and a peak in winter. While examining the Myriapoda community inhabiting the soil and litter fraction, different trends were observed, suggesting vertical kinesis as adaptation to soil moisture. Resembling Coleopteran composition, Myriapoda composition

differed in all habitats with respect to species dominance. Regarding Collembola, the most influential factor affecting total abundance was seasonality, with a low in summer and peak during winter. The data suggests that soil moisture is a key factor influencing Collembolan activity. Analysis of soil samples provided similar trends. Collembola abundance was influenced mainly by seasonality but not from silviciltural action. While examining Collembolan morphological groups, it is apparent that the composition throughout the year is similar between burned plot types but different than that of the control plots. It seems that the disturbance of fire itself, more than post fire actions, is the factor most formative of Collembolan community.

The Formicidae abundance was not influenced by habitat type nor by the interaction between habitat and season. Arachnid abundance was not influenced by seasonality. Despite this, a significant effect is attributed to habitat type, as well as to the habitat-season interaction, which distinguishes between burned and control plots. While examining the soil Acari, a higher abundance was found in burned plots. No statistical significance of abundance with respect to time was found for this group but this is likely due to insufficient sample size.

From the results of this study, some main conclusions may be inferred. It is apparent that fire has a major influence on abundance, richness, diversity and composition of the soil arthropod community, while post fire logging has an inferior influence. In addition, it is apparent that the seasonal effect is stronger than that of the silvicultural practice. Fire is the major form of disturbance, while salvage logging is a secondary disturbance agent. Regarding community composition indexes, logging is of stronger influence compared to no logging. It is likely that these differences are due to the different biology and habitat requirements of the different taxa. This suggests the need to examine each taxonomic group individually. Moreover, this research was conducted with temporal and spatial limitations. There is no doubt that the relevant processes are occurring and are expected to occur over a lengthy time period. In that respect, a long term monitoring process is needed in order to achieve a reliable estimation and understanding of the ongoing processes and the influence of logging on the ground dwelling arthropods inhabiting regenerating forest habitats.