ENVIRONMENT & SOCIAL TECHNICAL NOTE

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Contribution of Insect Biodiversity to Wood Decomposition

Summary

A long-term field experiment was established to determine the contribution of invertebrates to wood decay and subsequent release of nutrients in plantations. After twelve months in the field there were no significant differences between insect-present and insect-exclusion treatments. However, early results showed a decrease in the initial mass gain and wood density of experimental log billets when insects were present. Cerambycid larvae were present in the sub-cortical wood after twelve months and they are expected to rapidly accelerate the decomposition processes in the insect-present treatments over the next two years. After 36 months final nutrient release measurements will be taken.

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Aim

To quantify the contribution of invertebrates to the decay rate of above-ground coarse woody debris in *Pinus radiata* forests

Introduction

Coarse woody debris (CWD) is an important structural and functional component of forest ecosystems. It represents a large pool of stored organic matter and nutrients that provide habitat and resources for crop trees, and for a significant proportion of forest biodiversity, such as dead-wood-dependent (saproxylic) species like huhu beetles, bark beetles, and many species of weevils and click beetles. Managing forests for timber production alters the frequency and structural diversity of the CWD supply, which can have significant effects on saproxylic abundance and diversity [2]. Although the ecology and conservation biology of saproxylic species are relatively well studied (in some countries), there has been little quantification of the contribution that saproxylic invertebrates make to the decomposition rate and subsequent release of nutrients from dead wood. Edmonds and Eglitis (1989) found some evidence to suggest that insects promoted faster wood decomposition of Douglas-fir logs over a ten-year period in Cedar River near Seattle, USA. However, their small sample size of four trees made statistical inferences difficult.

In a New Zealand plantation context there are large amounts of CWD remaining after harvest. This significant store of nutrients cannot be utilized by the next rotation until it has been converted into a form available for plant uptake. This ecosystem service is largely performed by invertebrates and fungi, and thus biodiversity can make an important contribution to the recycling of nutrients in a forest ecosystem.

The aim of this trial is to quantify the proportion of wood decomposition attributable to the direct and indirect actions saproxylic invertebrates.

Methods

A replicated trial was established at eight locations around New Zealand (Figure 1).

Figure 1. Location of study trial sites

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Trial locations were chosen to assess two key environmental variables that are thought to influence wood decomposition rates; temperature and rainfall. Rates of wood decomposition are likely to be higher in warm, wet regions as opposed to colder or drier areas of the country. Insects were screened from timber billets (40-cm lengths of timber taken from a thinning operation at Bottle Lake Forest in Canterbury) by using cages with aluminium fly screen mesh (Figure 2). Samples available for insect colonisation were placed beneath an identical mesh screen to mimic potential changes in microclimatic conditions, such as interception of rainfall and shading; however their sides and base remained open to allow access by saproxylic invertebrates. The trial was established in January 2009 with further information on trial design given in [3]. Two samples have since been taken at six- and twelve-month intervals, with an additional two sample periods scheduled at 24 and 36 months.

Figure 2. Alwin Sky taking a GPS co-ordinate at Mahinapua Forest, West Coast. Note the paired design with complete insect exclusion at front, and an open-sided mesh screen at rear.

Results

Initial 'time zero' measurements were taken from 5-cm-wide sample discs cut either side of each log billet before they were placed in the field. These provided baseline estimates of the wood density for each log billet prior to decomposition. Results showed no difference in the initial mass or density of timber billets between the two treatment groups averaged across all study sites (Figures 3 and 4).

Figure 3. Average initial mass of central sampling disc from log billets.

Figure 4. Average initial density of central sampling disc from log billets.

Samples were collected after six and twelve months of decomposition. At this stage there are insufficient data points to plot traditional decay curves, and results are presented as the average percent change between zero and twelve months. As yet no significant differences are apparent in the percent change in mass or

density (Figures 5 and 6). In part this is because some bark beetle species were able to overcome the barriers we put in place to prevent colonisation of timber billets. However, bark beetles feed only on the phloem and cambium layers of the wood. As such their influence on long-term decomposition processes will be limited. In the twelve-month samples, insect tunnelling from cerambycid larvae (e.g., huhu beetle) was apparent in some insect attack samples. The influence of these cerambycid species on decomposition processes will increase over the next two years.

Figure 5. Average percent change in mass of central log discs after 12 months.

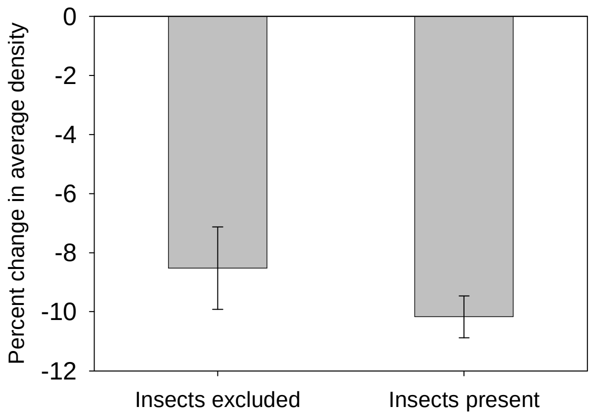

Figure 6. Average percent change in density of central log discs after 12 months.

Despite the high variability between treatment sites, several trends were apparent. On average, log billets gained more mass when insects were excluded (Figure 5). Frequently dead wood will initially gain mass as it is colonized by fungal hyphae that grow and import nutrients into the wood. Greater insect feeding activity in the insect-present treatment would thus reduce any apparent gains in mass caused by fungal colonisation. Similarly, insect feeding would reduce the quantity of wood biomass and leave air spaces in the timber billet. This is reflected in a decrease in the density of the wood (Figure 6). The difference in percent change in density between treatments may have been greater if bark beetles had been successfully excluded from the no-insect treatment. It will be interesting to assess changes in density as the action of cerambycid beetles increases over the next two years in the insect-present treatment.

Discussion

As yet treatment differences between insect presence and insect absence are not apparent. However, the dominant insect wood decomposers, the cerambycids, are only just beginning to feed sub-cortically in the logs. Over the next two years we expect to observe increasing differences in mass loss between log billets that were exposed to insects as opposed to those where insects were excluded. After 36 months' exposure in the field, final measurements will be taken and the mass loss and nutrient release attributable to invertebrate biodiversity will be calculated.

References

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