FIA-FSP Project Number and Title: Y073049. Green tree retention: a tool to maintain ecosystem health and function.

Project Purpose and Management Implications:

The purpose of this project is to determine (i) if green tree retention on harvested sites is a suitable management option for maintaining 'healthy' soil (in terms of maintenance of soil organisms and their associated functions), and (ii) what size and density of green tree retention patch is required for this purpose. The results will be used to revise guidelines for forest management practices to better protect the soil resource and preserve biodiversity. The effect of harvesting on soil organisms and associated functions is a critical knowledge gap that precludes certainty about the sustainability of current and proposed forestry practices. The decisive knowledge achieved through this research will allow BC forest managers to develop and use practices that are based on sound, defensible science and put BC at the forefront of forest research to support sustainable forest practices.

B.C.'s Forest Practices Act, Canada's National Forest Strategy and Canada's Biodiversity Strategy all emphasize the importance of maintaining forest biological diversity, the ecological integrity of forests and ensuring sustainable use of forest resources. Current policies, regulations, and guidelines do not sufficiently consider the importance of soil organisms to the maintenance of ecological functions. This is largely because the scientific information does not yet exist to guide decision-making.

Project start date, length of project and any former numbers or funding sources that apply:

April 2004 (Y051049; Y062049). 3 years.

Methodology overview:

In the first two years of the project we worked on replicate 2 of STEMS, which was harvested in summer 2005. This allowed us to collect pre- and post-harvest data on soil microbial and faunal communities and nutrient cycling processes. In year one we sampled what will be the center of each of 4 replicates of 4 different retention patch sizes (5m, 10m, 20m and 40m diameter) and at the edge of each patch and then 30 m out from what will be the retention patch edge into the clear-cut. This was to determine any pre-harvest spatial variability in soil organisms which may confound our post-harvest analyses. We characterized microbial and faunal communities in the forest floor and mineral soil of this even-aged (60-70 yr) stand of western hemlock (*Tsuga heterophylla*) and Douglas-fir (*Pseudotsuga menziesii*). The diversity of ectomycorrhizal fungi was assessed using morphological and molecular methods. The diversity of the soil microorganisms was assessed using molecular fingerprinting techniques (Denaturing Gradient Gel Electrophoresis). Catabolic fingerprinting and enzyme profiling were used to assess microbial functioning. Catabolic fingerprinting measures CO_2 release before and after addition of a variety of substrates, which indicates the size of the microbial biomass and provides a community-level physiological profile. Enzyme profiling enables characterisation of the actual functional diversity of the soil microbial community in terms of decomposition and nutrient cycling processes as the enzymes are involved in

cycling of C, N and P. Soil mesofauna (mites, collembolan, nematodes) were extracted from the soil using standard wet and dry extraction techniques, and identified to species or morphospecies. The abundance and community structure of the soil macrofauna (worms, millipedes, centipedes) were determined using Tullgren funnels and hand sorting. Nutrient availability in the field was determined close to each sampling point in the transect, using ion-exchange membranes (PRS probes) for both anions and cations. In November 2005 we sampled the STEMS 2 site post-harvest for soil microbial and faunal communities. We took the post-harvest samples in November to minimize any temporal effect of sampling as we took the pre-harvest samples in November 2004. We sampled the center of each retention patch and at the edge of each retention patch and then along a transect from the retention patch edge going 30 m out from the retention patch edge into the clear-cut (taking samples at 5, 10, 15, 20 and 30 from each retention patch edge; data from other trials indicate that most changes take place within 10-15 m of the edge). In the final year of the project we used the first replicate of STEMS (STEMS 1), which was then 5 years post-harvest. This allowed us to compare the longer term effect of VR harvesting on soil diversity and function and also to address which spatial arrangement of green trees best preserves soil health, dispersed, or aggregated retention.

Project scope and regional applicability:

The project is using the STEMS long-term research installations (LTRI026 EP1213) at the Snowden Demonstration Forest, Campbell River (STEMS 1) and Elk Bay (STEMS 2), Vancouver Island, as its study sites, in the coast forest district. The findings should be applicable to other forest districts.

Interim conclusions, inference or information that may be useful to forest practitioners and other researchers:

Analyses of our pre-harvest samples at STEMS 2 showed that less than 5% of the soil faunal population were found in the mineral soil. The forest floor harboured a distinct microbial community from the mineral soil in both composition and function as measured using enzymatic and catabolic profiles. These results indicate that the forest floor is a critical reservoir for soil organisms in this forest. One of the benefits, therefore, of green-tree retention may be retention of undisturbed forest floors in the retention patches, which could serve as refugia for colonization of disturbed areas following harvest.

This was confirmed by the analyses of post-harvest samples which have shown that populations of most of the soil macrofauna and Collembola are influenced more by the amount of disturbance of the forest floor, than by the influence of living trees. However, soil mites and pauropods showed a decline in abundance from the centre of the patch to the edge and out into the cut area, which may be related to differences in their food sources, pauropod guts were full of bacteria, bacteria rely mainly on readily utilizable C for growth from root exudates.

Ectomycorrhizal diversity decreased substantially by 10 m from patches of green trees suggesting that the ‘shadow’ cast by these patches is quite small. However, patch size was not important to ectomycorrhizal diversity at the centre of the patch, therefore,

dispersed retention would likely be a more effective method of retaining a high diversity of ectomycorrhizal inoculum for the next rotation.

Twenty meter retention patches seemed to be the optimum size, as far as maintaining soil hydrolytic enzyme activity closer to pre-harvest levels, but sampling location didn't make a significant difference within or beyond any plot size for any of the enzymes we assessed. Availability of nitrogen was higher outside the patch than in the centre of the patch after harvest.

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