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Methylmercury build-up in above ground logging residues

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Forest harvest might mobilize mercury (Hg) retained in soils and promote the transformation of inorganic Hg to its more bioavailable and toxic form methyl-Hg (MeHg). Previous studies, however, have revealed considerable variation in effects of forest harvest on the runoff of total Hg (THg) and MeHg between sites. This study addresses one factor that may influence the forestry effect: the impacts of logging residues left on site after forest harvest. The availability of labile organic matter (OM) as electron donors for Hg methylators has previously been proposed as a central factor causing higher MeHg formation in forest harvested areas. However, to the best of our knowledge, there are no studies that have evaluated the processes associated with a possible increase in MeHg production under and/or in piles of logging residues.

In this field-based experiment at Skogforsks´ test site in south-central Sweden (303 Tobo), we have evaluated mechanisms that may cause enhanced MeHg production in biofilms associated with logging residues and/or in soils underlying piles of such residues. The experimental setup included 12 sample plots, half with soil covered with residues and half without residues. Residues samples consisting of Norway spruce needles, were collected from upper and lower part of the pile, and soil samples were collected from soil covered and not covered with residues. Temperature and moisture were registered continuously using sensors. Soil water, for OM quality measures, were collected using lysimeters. Microbial communities were analyzed using DNA extracted from soils and residues to assess the relative abundance of Hg methylating microorganisms. Three sampling occasions (spring, summer and autumn) covered a variation in temperature and soil moisture.

Contrary to our hypothesis, there was no difference in MeHg concentrations or the ratio of MeHg (%MeHg) in soils covered (n=18) or not covered (n=18) with logging residues. Instead, the piles of above ground logging residues accumulated high concentrations of MeHg. The %MeHg was significantly higher in the residue piles, both in the top and bottom (n=32), compared to the

underlying soils (n=32). The concentrations of MeHg were slightly higher at the bottom of the pile compared to the top, possibly because of reduced temperature amplitudes, higher moisture, and larger pool of THg at the bottom of the pile. Microbial analyses also indicated a higher overall bacterial abundance and interestingly also a higher abundance of archaeal hgcA genes in above ground residue samples compared to underlying soil samples, implying methanogenic conditions in the biofilm with possible influence on MeHg production. These results suggest that MeHg are formed in suboxic/anoxic microenvironments favored by access of OM from decomposing logging residues in the biofilms of the substrate itself.

In summary, we show that hotspots of MeHg are not only found in soils and waters but also in biofilms above-ground. Logging residues left on site after forest harvest can thereby be a source of MeHg. However, the presence of logging residues can also protect the soil from disturbances by off-road traffic and thereby prevent the potential mobilization of MeHg in ruts.