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Redox potential: An indicator of site productivity in forest management

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Redox potential (Eh) is an integrated soil measurement that reflects several environmental conditions in the soil associated with aeration, moisture and carbon (organic matter) dynamics. Its measurement can be related to water table fluctuations, precipitation and landscape gradients, organic matter decomposition rates, nutrient dynamics, biological diversity and plant species distribution. Redox is an excellent indicator of soil biological processes, as it is largely a reflection of microbial activities which to a large extent govern carbon dynamics and nutrient cycling. Redox thus serves as an ecological indicator of site productivity at the ecosystem scale and may be used for management purposes as its magnitude can be altered by activities such as harvesting and drainage. A threshold value of 300 mv has been documented as the critical value below which anaerobic conditions in the soil develop. However, redox measurements and its impacts on ecosystem processes such as nutrient cycling and productivity, especially in forest ecosystems, have not received the attention that this "master" variable deserves,

On northern Vancouver Island, Canada, regenerating stands of western redcedar-western hemlock (CH) sites exhibit symptoms of nutrient deficiencies and slow growth, but this phenomenon does not occur on adjacent western hemlock- amabalis fir (HA) sites. We tested the hypothesis that differences in nutrient supply and distribution of plant species was caused by differences in moisture regime and redox potential. Redox potential, pH, soil aeration depth (steel rods), organic matter thickness, bulk density, soil carbon store, plant species distribution and richness were measured at five old-growth and five 10-year-old cutover blocks. Results of investigations confirmed that CH forests were wetter, had redox values lower than the critical 300mv and a shallower aerated zone, compared with adjacent regenerating HA sites. Fifty percent of the CH plots had redox values less than +300 mv in the forest floor; whereas only 15 percent of the HA plots had such low values. Composition of the forest understory species was related to soil moisture/aeration. Soil aeration was the most important soil variable influencing plant species composition, explaining 25% of the plant community variability. Eh was always greater than +300 mv in the mineral soil of old growth HA forests but below +300 mv in HA clearcuts, suggesting paludification; however it was below or at this threshold in both CH forests and clearcuts. The reduction in measured redox without a noticeable change in the watertable in HA sites suggests that harvesting HA forests shifts the ecosystem towards more anaerobic conditions more similar to CH sites.

In a complimentary study, the significance of redox was assessed in a cedar swamp cutover by exploring the relationships between soil redox potential and tree growth, and mineralization of C and soil C store along a gradient of moisture caused by drainage. Drainage improved aeration in the rooting zone, expressed as redox, and above- and below ground C storage; however C mineralization measured as CO2 evolution was not affected. Tree growth was positively correlated with redox potential. Our results indicate that drainage could be a useful silvicultural practice for improving the productivity of these ecosystems and that it may be possible to improve tree growth without stimulating loss of soil C. This requires that drainage improve aeration in the rooting zone while maintaining redox levels of less than +300 mV in the bulk soil, indicating that redox measurements should be incorporated into silviculture interventions to improve productivity of these forests.