Preventing Nitrogen Depletion in Forests Undergoing Forest Residual Removal

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Introduction:

Soil nutrient information plays a key role in determining how forest residual removal can be done in a way that is both environmentally sustainable and economically viable. Nitrogen, specifically, is a valuable indicator of potential forest growth. The purpose of this study is to incorporate deep soil data into an existing stability ratio. This gives more accurate information about the total nitrogen stock. This in turn provides a more accurate representation of how much above ground biomass can be removed without creating a nitrogen depletion risk. Whole tree harvesting involves the extraction of the entire tree from the site, while stem only harvesting leaves behind branches, bark, foliage, etc. Due to the nutrient rich qualities of various forest residuals, whole tree harvesting removes a much larger portion of the biomass nutrient stock than stem only harvesting. [1]

Methods:

The nitrogen stock (kg/ha) was calculated for 27 sites and at 8 soil depth levels that went down as far as 3 meters (previous studies only went down to 1 meter).[2] [3] The total stock was calculated by the multiplication of the bulk density at each depth with the layer height and the percent composition of nitrogen of individual samples, which were analyzed by a CHN analyzer. The nitrogen removal estimates were found by using mathematical models to predict tree growth up to harvest age. From those models, estimates of nitrogen levels were made and then removal quantities were predicted based on the type of harvesting that was to be done (whole tree vs stem only). [1]

Objectives:

- Determine bulk density at various soil depths
- Determine nitrogen stock at various sites
- Incorporate calculated nitrogen stock values into an existing stability ratio
- Provide an accurate representation of the sustainability of forest residual removal

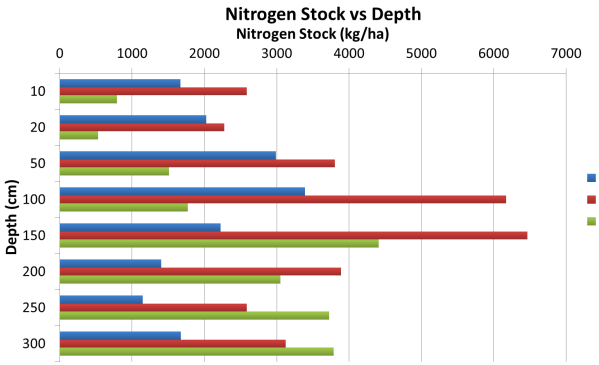

Figure 1. Above is a bar graph that shows the change in nitrogen stock between various soil depth layers. The stock was calculated by the multiplication of the column height by the % nitrogen concentration by the bulk density.

Results[1]:

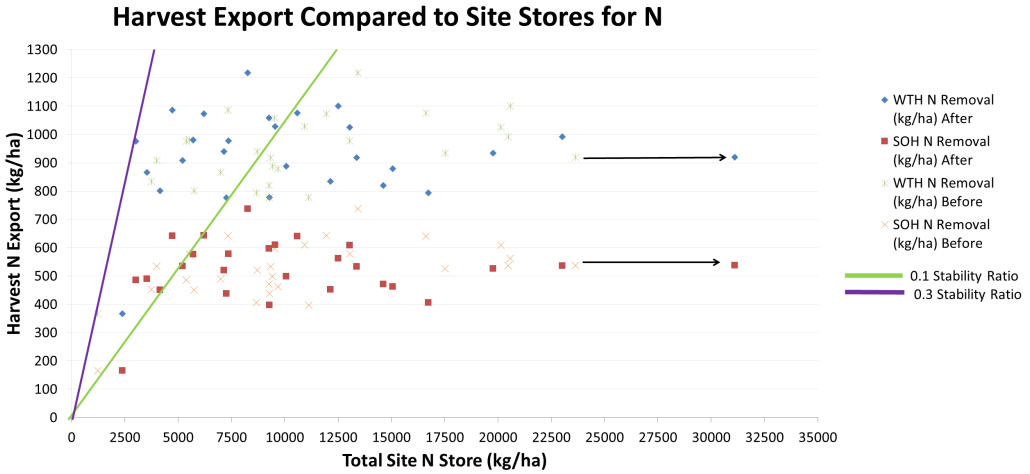

Figure 2. Above is a scatter plot where each point represents an extraction site and its relative distance from the stability ratio. Green asterisks' and orange X's represent the location of the points prior to this study while blue diamonds and red squares represent the location of the points after taking the new data into consideration. The green line represents a stability ratio of 10% nitrogen removal while the purple one represents a ratio of 30% nitrogen removal.[1] Points to the right of the green line represent sites that are not at risk of nutrient depletion and could potentially handle larger extraction rates. Points to the left of the purple represent sites that are at risk of depletion and require much more caution in terms of extraction. The results of this study show an overall shift to the right due to evidence of larger nitrogen stocks. Minor exceptions include points that were actually shifted to the left and can be attributed to the difference in pit locations and bulk density values between the two studies.

Conclusion:

This research shows that removal of ≤10% of the total nitrogen stock at a site does not put the site at a risk of nitrogen depletion. Removal of ≥10% and ≤30% begins to bring about a risk that is not significant but present. Removal of ≥30% begins to raise significant risk of nitrogen depletion and requires greater caution when continuing to extract forest residuals from that site.[1] The 10% sustainable removal percentage was determined via estimates of the rate of natural nitrogen replenishment. The 10% removal percentage indicates that only 10% of the total nitrogen stock at a site should be removed per rotation length of the Douglas-fir (approximately 40 years).[1] It is estimated that over this time period the nitrogen stock would fill back up via natural processes such as atmospheric deposition and biological nitrogen fixation and therefore the forest residual extraction would be sustainable.

Future Work:

Work that could be done to create further progress with these results includes creating a system in which 10% of the total nitrogen stock is calculated and given a practical value and tangible biomass quantity for those actually performing the sustainable forest residual extraction.

Acknowledgements:

This work, as part of the Northwest Advanced Renewables Alliance (NARA), was funded by the Agriculture and Food Research initiative Competitive Grant no. 2011-68005-30416 from the USDA National Institute of Food and Agriculture.

References:

[1]Himes, Austin, Eric Turnblom, Robert Harrison, Kimberly Littke, Warren Devine, Darlene Zabowski, and David Briggs. 2013. "Predicting Risk of Long-Term Nitrogen Depletion under Whole-Tree Harvesting in the Coastal Pacific Northwest." *For. Sci.* 60(1)

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[3] LITTKE, K.M., R.B. HARRISON, D.G. BRIGGS, AND A.R. GRIDER. 2011. "Understanding soil nutrients and characteristics in the Pacific Northwest
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