NARA Research Briefs

Dr. Doug Maguire, Oregon State University
Estimating Nutrient Removals under Varying Intensities of Harvesting Residue Utilization

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Nitrogen is the most abundant atmospheric element and a major nutrient required for plant and tree growth. The vast majority of nitrogen in forest soils and tree biomass is fixed from the atmosphere by soil micro-organisms. Although the vast majority of nitrogen in most forest ecosystems is held in soil organic matter, some sites contain larger portions in live biomass and may therefore be susceptible to reductions in long-term site productivity if sufficient quantities are removed during timber harvest and biomass utilization. In a recent interview, Dr. Doug Maguire of Oregon State University discussed his current research regarding quantification of nitrogen and other nutrients that are removed under varying utilization intensities of harvest residues in intensively managed Douglas-fir forests. The first step in this research is to build biomass equations appropriate for the much wider combined variability in tree diameter, height, and crown size that results intensive management relative to unmanaged stands. Biomass equations in this context are formulas that help us estimate the relative percentages of both merchantable and non-merchantable materials in any given tree. Application of these equations allow us to estimate the fractions of bark, wood, and foliage that are both removed for conventional wood products and left behind as unmerchantable biomass. “Our primary objective is to get the biomass equations to provide us with accurate estimations of the biomass components in a tree”, stated Maguire. Armed with these equations and measured nutrient concentrations in each respective biomass component, nutrient removals can be estimated under a wide range of management scenarios. Further, he added that “Currently, the biggest unknowns are the site replenishment rates. If we remove the merchantable wood, how much of the total nutrient capital will have been removed?”

If reasonably sound biomass equations and nutrient concentrations are available, scientists can better predict nutrient and biomass balances that result from the combination of harvesting outputs and natural inputs. With traditional harvesting, the tree is felled and limbed in the forest before being yarded to the landing. This leaves behind a scattered source of nitrogen-rich biomass contributing to the above-ground and eventually below-ground nitrogen pools. However, in the case of whole tree harvesting, the entire tree including limbs and foliage is yarded to the landing where it is limbed to produce clean logs for transport to a mill. Although this method leaves biomass in a collective pile, Maguire wonders how much nitrogen is being taken from the woods and whether these removals impact the sustainability of management on a larger scale. “We have a disproportionately large portion of nitrogen in a tree’s foliage. Whole tree yarding may potentially become an issue if the branches and foliage removed from the forest contain a significant portion of the total nutrient pool.” If the size and fate of these biomass components can be quantified, researchers will be able to calculate potential impacts to overall site productivity.

Along with estimating nitrogen pools and losses from harvesting, the amount of biomass in different tree components is difficult to measure accurately. In this research, the quantified components include foliage, branches, heartwood, sapwood, and bark of Douglas-fir. By determining the amount of biomass in each component and the nutrient concentration of that biomass component, the nutrient content of each tree and the entire stand can be estimated. Removals of various components for biofuel feedstock can then be translated into potential impacts on soil fertility and forest nutrients. Although sustainable management is the primary goal, research such as Maguire's looks at incorporating more information beyond traditional stem volumes of growth and yield models. "When we construct these models, we try to estimate net primary production from soil and climatic conditions" stated Maguire.

In addition to the appeal that this research offers to interested scientists and principal NARA investigators, how might this information be useful to landowners and managers? "With the general decrease in timber market value with the recession, along with increasing energy costs, it is crucial that investments like fertilization be applied to areas that need fertilizers the most" stated Maguire. With deeper understanding of biomass distribution among components, nutrient content and concentration, and nutrient replenishment rates, forest managers and landowners would be able to determine if and where their forest lands may require nutrient additions after removals in both conventional wood products and biofuel feedstock. Not only does this information hold potential for better return on fertilization investments, it would also assist the scientific community in identifying the best biofuel feedstocks. As Maguire states, "Our job is to let landowners know how much biomass they can generate and how much they need to leave in the woods in order to sustain their forest."

In addition to research on below- and above-ground nitrogen pools, models that simulate forest productivity also have the potential to more accurately determine carbon sequestration. "There is a lot of misunderstanding about timing and magnitude of carbon sequestration. Should we thin or not, and how do we manage the forest with the intention of sequestering as much as possible in the woods or in durable wood products, while also satisfying the demand for wood products?" stated Maguire. When harvest activities occur, carbon dioxide is created both from fossil fuels burned during the thinning and from the decomposition of logging residues. As the concern for atmospheric carbon dioxide level increases, researchers worry about the detrimental effects these levels have on climate change. Although quantifying and modeling these data is a challenging endeavor, Maguire enjoys seeing all of this work condensed into a final product for the purpose of improving forestry and land management.

Works Cited

Maguire, Dr. Doug. (2014, March 7). Personal Interview.