PROJECT ID: CAFS. 18.73

PROJECT TITLE: Analysis of Aboveground Nutrient Biomass on LTSP Sites Due to the Effects of Site, Harvest Removals, Weed Control, and Compaction

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PROJECT DESCRIPTION:

Four Long-Term Soil Productivity (LTSP) sites (Figure 1) have experienced different soil and foliar nutrition and stand volume growth outcomes as a result of organic matter removals and vegetation control or compaction treatments over 5-20 years since harvest. Five years of annual vegetation control resulted in losses of forest floor and soil N and base cations but tended to increase stand volume growth from 0-10 years. Organic matter removals resulted in variable changes in soil and foliar nutrition based on limiting pre-treatment soil nutrients. Soil, forest floor, and foliar nutrient concentrations were affected by all treatment types yet the effects were variable among sites.

The results from above- and belowground nutrient concentrations suggest that aboveground nutrition should be examined on these sites because we cannot determine if the changes in belowground nutrition between treatments are due to losses through nutrient removals, leaching and/or greater uptake by aboveground biomass. While three of these sites have been examined for aboveground biomass and nitrogen in the past, aboveground cations and phosphorus have never been measured on these sites.

The role of understory species on these sites have not been measured for 10-15 years. Most recent measurements at the oldest site (Fall River) suggest that the effect of vegetation control appears to be decreasing because there was no significant difference in stand volume growth from 10-15 years while the initial vegetation control treatment was previously growing significantly less than the annual vegetation control treatments. This finding supports an investigation into the ability of understory species in retaining and supplying nutrients as sites enter canopy closure stage. Understanding how these nutrient dynamics work over the longer term may contribute to better timing and selection for chemical nutrients and/or herbicides.

HYPOTHESES or OBJECTIVES:

- Examine aboveground biomass and nutrients on four LTSP sites
- Compare biomass allocation equations to previously established biomass allocation equations
- Understand the nutrient holding capacity of understory species due to treatments on each LTSP site
- Compare the previous results of treatments on belowground nutrient biomass to aboveground nutrient biomass

METHODS:

The Matlock, Molalla, and NARA LTSP sites will be measured in the fall of 2018 and the Fall River LTSP site will be measured in 2019. At each site and plot, one whole tree of average height and DBH will be harvested to determine biomass allocations. Samples will be dried, weighed, and analyzed for total N, Ca, Mg, K, and P.

To calculate Douglas-fir component biomass, we will use sampled tree measurements (diameter at 15 cm [D15], DBH, DBH:QMD ratio, height, crown ratio, D15^2*height, and stem volume) along with previous tree measurements (Devine et al., 2011, Harrison et al. 2009, Devine et al., 2013) to determine the best predictors of tree component biomass. The biomass equations that are produced for Douglas-fir stem, branch, foliar, and total biomass will be applied to the measurement trees in each LTSP site to estimate Douglas-fir component biomass in each plot.

During the summer prior to biomass sampling, competing vegetation biomass will be sampled on each plot using randomly placed subplots of known area. Competing vegetation will be split into understory (herbaceous and small shrubs) and overstory (large shrubs and trees) competing vegetation components to define the relationship between the vegetation and Douglas-fir. Competing vegetation biomass samples will be composited by type and plot. Douglas-fir and competing vegetation samples will be dried, weighed, and analyzed for total N, Ca, Mg, K, and P to determine nutrient contents.

MAJOR FINDINGS:

NARA

- Crown volume was the best predictor of foliar, branch, and total biomass in five-year-old trees.
  - NARA contained 2X foliar biomass than Fall River at the same crown volume, which suggests that optimal pre-treatment soil nutrients, greater annual growing degree days, and improvement in genetics can increase foliar biomass in young trees.
  - Stem biomass was strongly related to stem volume.
- WT removals decreased forest floor N content, while compaction increased soil and total C and N biomass (Figure 2A).
  - Increases in total C and N due to compaction are likely due to mixing of the forest floor into the mineral soil and a decrease in decomposition in compacted soils.
- Compaction also resulted in decreases in soil exchangeable K content compared to uncompacted soil yet did not cause significant changes in total site K content (Figure 2B).
  - Decreases in soil exchangeable K could be due to greater proximity and uptake by roots in compacted soils.
  - An increase in soil exchangeable Al content also suggests that base cations were replaced with Al on soil exchange sites (Figure 2C).

Fall River, Matlock, and Molalla

- 20-year and harvest tree needle and branch biomass at Fall River were lower than 11- and 15-year trees at all sites due to dense stands causing rising crowns.
- Net N biomass tended to increase in WT treatments (greater mineralization or Scotch broom N-fixing) and decrease in the AVC treatment (greater leaching after harvest) (Figure 3A).
  - Forest floor N biomass decreased the most at Fall River in the WT+ treatment due to greater mineralization after harvest.
  - Forest floor N increased at Molalla due to greater forest floor mass in the WT treatment.
  - At Matlock, Scotch broom competition increased site N biomass in WT and AVC treatments.
- Soil Ca decreased at all sites due to WT and AVC treatments (Figure 2B).

- At Fall River, decreases in net Ca biomass were up to 31%.
- The AVC treatment increased Douglas-fir Ca biomass at Matlock and Molalla due to decreased uptake by competing vegetation.

- WT treatments decreased site K biomass due to organic matter removals, but the AVC treatment increased Douglas-fir K biomass at Fall River and Matlock.
- WT removals resulted in a decrease in site Ca and K due to permanent removal of needles and branches. These removals were extreme at Fall River and Matlock where soil exchangeable cations were low prior to treatment.
- Annual vegetation control improved Douglas-fir nutrient biomass. However, net losses in site nutrients were likely due to increased leaching after five years of annual vegetation control.

DELIVERABLES:

Overstory and understory biomass sampling at Fall River, Matlock, Molalla, and NARA sites were completed. We have developed separate biomass allocation equations for 5-year and 5-50-year regional Douglas-fir using standard tree measurements. One manuscript has been published in Forest Ecology and Management. Two manuscripts are in preparation based on the results of this project.

MEMBER COMPANY BENEFITS:

This study instructed forest product companies on the short- and long-term changes in soil and site productivity due to intensive forest practices. We improved the understanding of nutrient dynamics following organic removal, vegetation control, and compaction over the short- and long-term. Knowledge of how these factors interact will lead to better timing and application of chemical nutrients and/or vegetation control measures.

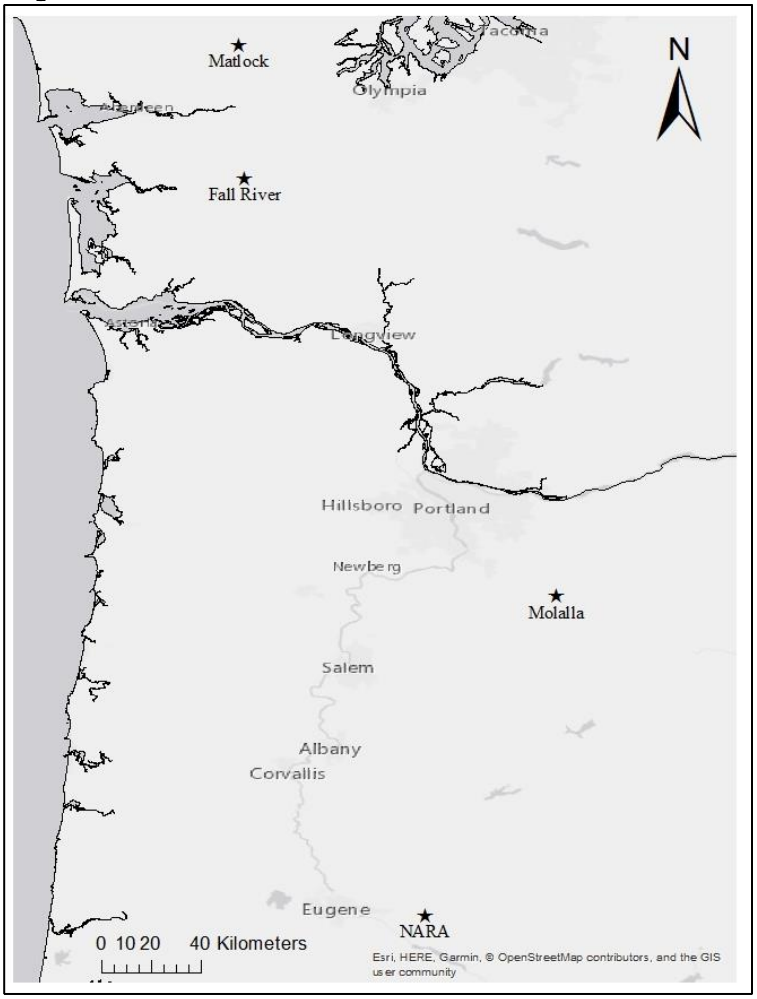
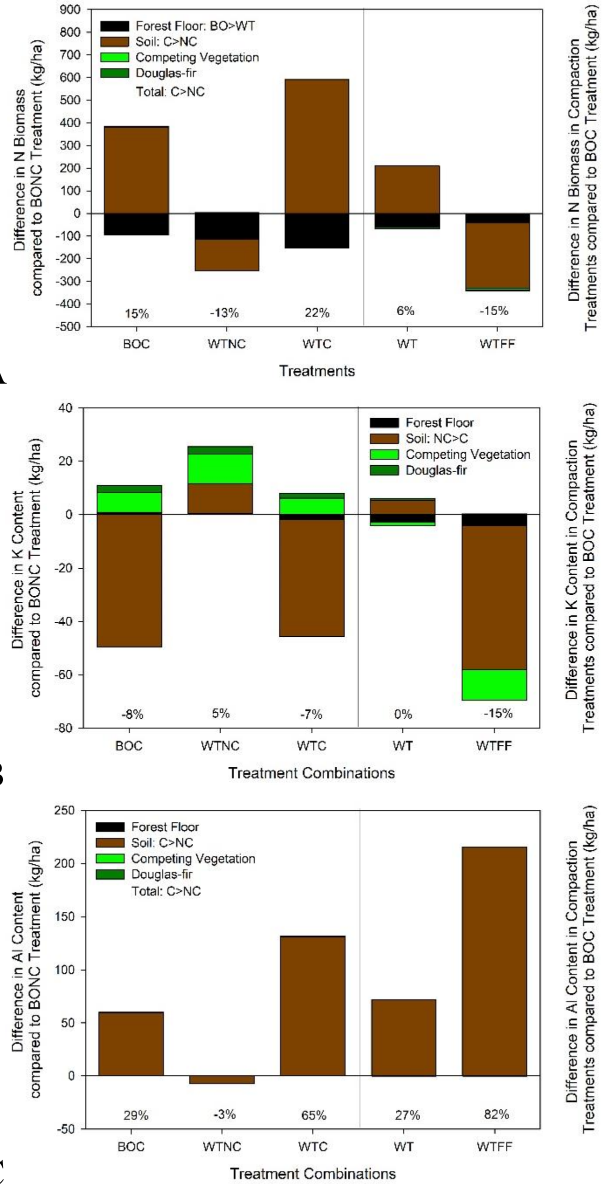


Figure 1. Long-Term Soil Productivity sites in Washington and Oregon.



A

B

C

Figure 2. Change in net N (A), K (B), and Al (C) biomass compared to the BONC treatment (left panel) and the BOC treatment (right panel).

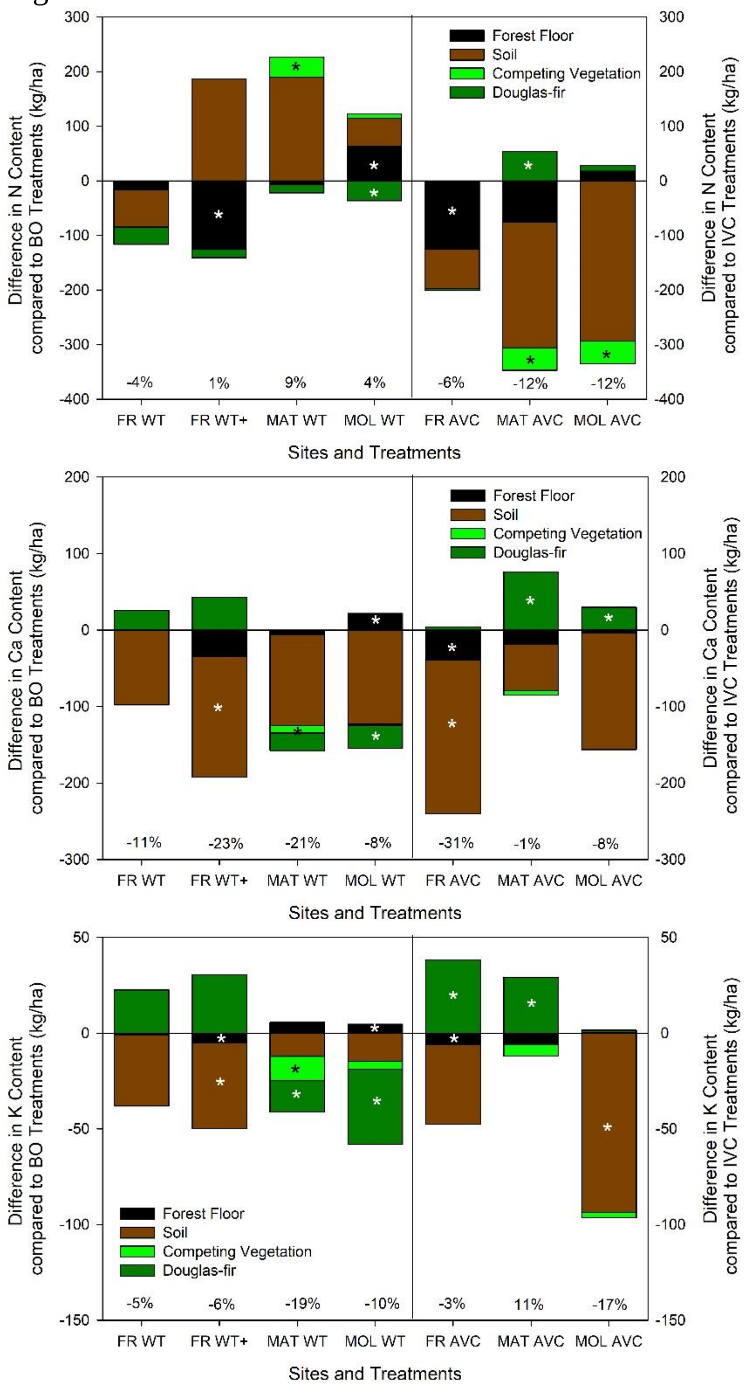


Figure 3. Change in net N (A), Ca (B), and K (C) biomass compared to the BO treatment (left panel) and the IVC treatment (right panel).