Carbon and N in Deep Soil Profiles of Coastal PNW Douglas-fir Plantations

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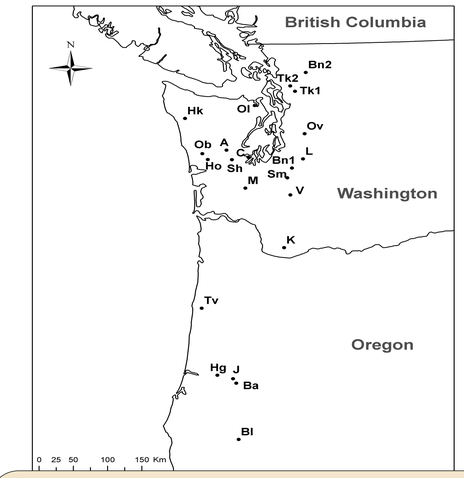
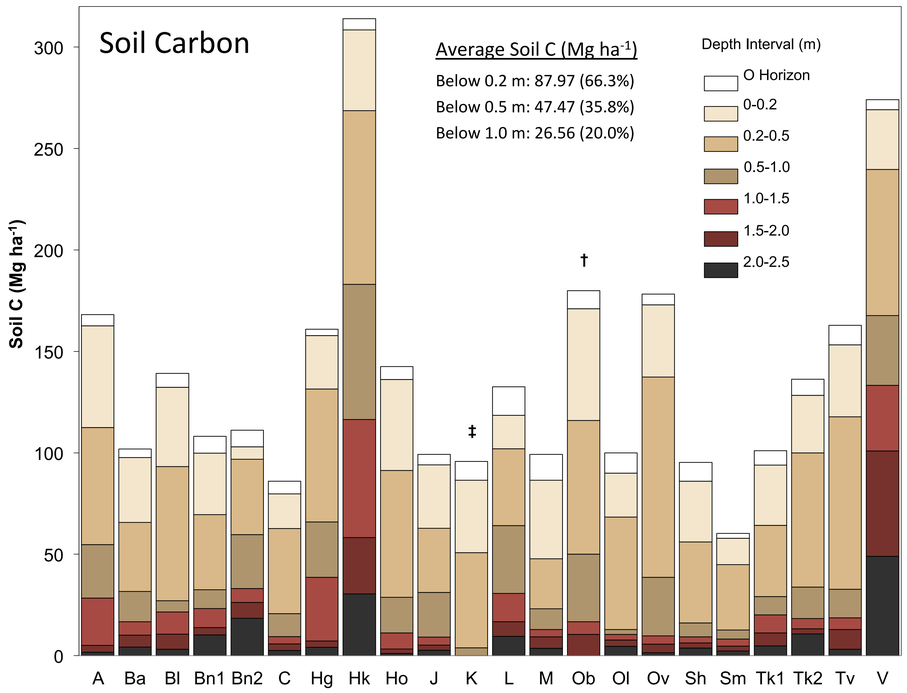
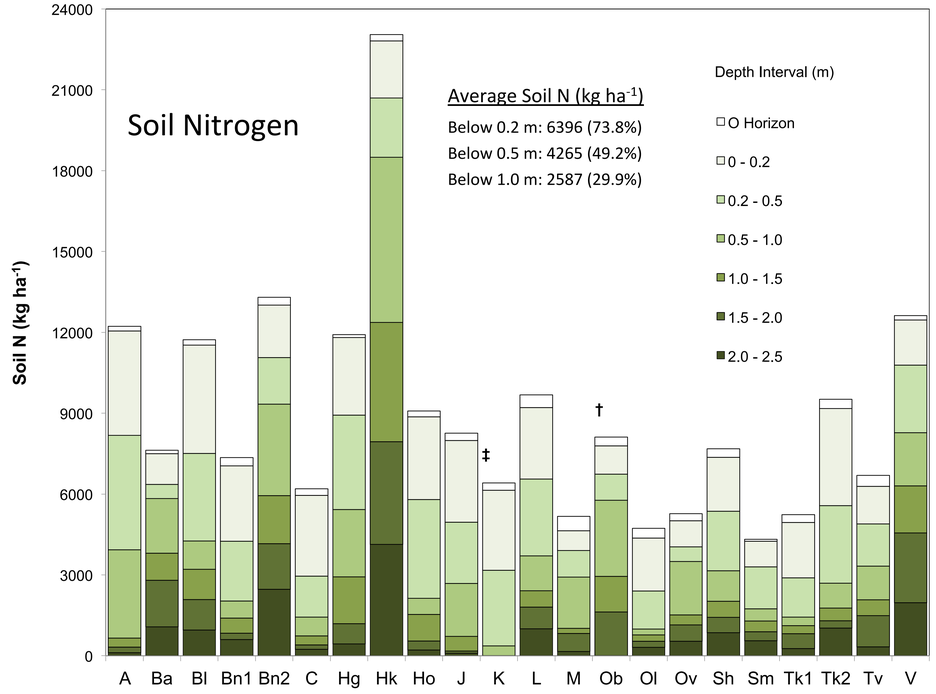
Methods

- 22 study sites in intensively managed plantations across the Pacific Northwest Douglas-fir zone
- Excavator used to dig at least 2.5 m deep soil pits
- Bulk density samples taken at intervals of:
  - 0 to 0.2 m
  - 0.2 to 0.5 m
  - 0.5 to 1.0 m
  - 1.0 to 1.5 m
  - 1.5 to 2.0 m
  - 2.0 to 2.5 m
- Forest floor gathered from randomly placed 0.3 x 0.3 m quadrat
- Samples analyzed for C & N







Figures 2 & 3. Soil C (Mg ha^{-1}) and soil N (kg ha^{-1}) within each sampled depth interval for 22 forest soils in western Washington and Oregon. † Soil pit excavation impeded by compacted glacial till at 2.0 m. ‡ Soil pit reached igneous bedrock at 1.0 m.

Can Management Practices Alter Deep Soil?

Soil Carbon

Studies indicate:

- That ignoring deep soil C can alter conclusions regarding both soil C stocks and fluxes (Canary, et al. 2000; Harrison, et al. 2011).
- That nitrogen fertilization can significantly increase C storage in some soils (Adams, et al. 2005).
- That differences in soil C between harvest treatments at Fall River (bole-only, with and without vegetation control, and total tree plus forest floor removal) become greater deeper in the soil profile (Knight, 2013).

Conceptually, management practices can alter deep soil C through:

- Acidification due to fertilization increasing availability of Al-Fe to form organic complexes.
- Changes in root input of C to deep soil layers after harvest and during vegetation control.
- Changes in dissolved organic matter quantity and quality due to alterations in the forest floor after harvest, which in turns changes C leaching rate to deeper parts of the profile.

No studies have examined effects of forest management on soil deeper than 1.0 m in the Pacific Northwest. This is a major deficiency in our understanding of soil dynamics.

Soil Nitrogen

Nitrogen leached deeper than 1.0 m is traditionally considered lost to the system. However, significant amounts of N may be found below this depth that may still interact with forest biota. Soils of volcanic origin can develop a significant anion exchange capacity (AEC) due to the presence of allophane, imogolite, ferrihydrite, and other Al-Fe oxides (Strahm and Harrison, 2007).

In addition to playing an important role as a source of water during the dry summer months, volcanically-altered deep soil may be a sink of nitrate, phosphate, and sulfate leached from the surface and a source of these nutrients to trees and other plants.

Adsorption of nitrate to positively charged sites in deeper parts of the soil profile slows the loss of N from leaching and increases the potential for tree uptake or recycling through microbial biomass. Rewetting of dry surface layers during the summer through capillary movement from deep, moist layers could provide an upward flux of nitrate in soils where N is stored at depth.

Although root density greatly decreases below surface horizons, this study found an average maximum rooting depth of 1.4 m with isolated roots found as deep as 2.3 m.

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