Effects of Geoclimatic Factors on Soil Nutrients and Site Productivity of Douglas-fir

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Introduction:

• Douglas-fir grows on many different soil types over the coastal Pacific Northwest.

• Soil development has been influenced by parent materials that formed over different geologic time periods.

• Distinct climatic regions have also been identified in the Pacific Northwest due to the proximity of the coast and mountains.

• The combination of climate and soil types affect Douglas-fir productivity throughout the coastal Pacific Northwest.

Hypothesis:

- Boosted regression tree models can describe the relationships between climate, site, and soil variables that determine soil and site productivity.

Objectives:

- Develop models for predicting soil and site productivity.
- Map soil and site productivity across the coastal Pacific Northwest.

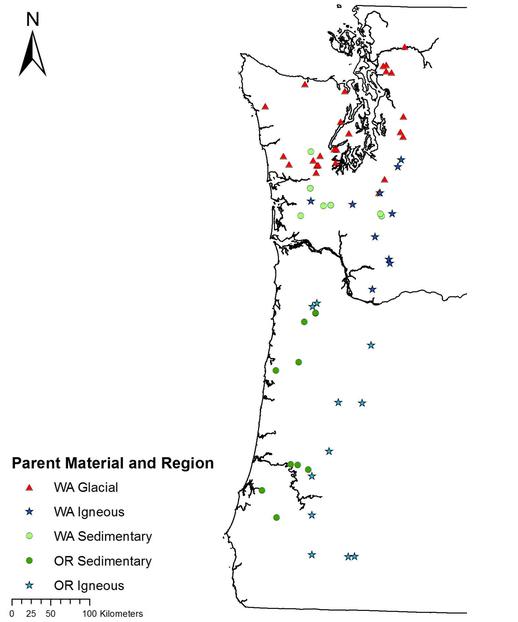

Figure 1. Study installations in the Pacific Northwest.

Table 1. Boosted regression tree models of soil and site productivity.

Total Soil N Content R^2=0.75			Forest Floor C:N Ratio R^2=0.65			Site Index R^2=0.66		
Predictors	**Range**	**RI**	**Predictors**	**Range**	**RI**	**Predictor**	**Range**	**RI**
Clay Content	>25%	30	Regional Parent Material	OR Igneous	44	Available Water Supply	>100 mm	39
Available Water Supply	>100 mm	21	Available Water Supply	<150 mm	22	Elevation	<500 m	26
Sand Content	<40%	18	Precipitation as Snow	>100 mm	17	April Precipitation	>110 mm	15
Organic Matter	>6%	16	August Precipitation	>20 mm	7	December Temperature	>3 C	9
Regional Parent Material	OR Sedimentary, WA Igneous, WA Glacial, WA Sedimentary	10	Longitude	<-123.5°	6	Precipitation as Snow	<100 mm	5
November Temperature	>7° C	6	February Temperature	<5.5 C	3	Clay Content	>30%	5

Materials and Methods:

• 71 14-28 year-old Douglas-fir installations were established in Oregon, and Washington between 2007 and 2011 (Figure 1).

• Installations are located in Sitka spruce, western hemlock, and mixed conifer-evergreen zones.

• Slope, elevation, and aspect were measured for each installation.

• Average monthly installation temperature and precipitation was calculated using ClimateWNA (1990-2011).

• Soil clay, sand, organic matter, and available water supply were determined from NRCS soil series data.

• Forest floor carbon to nitrogen (N) ratio and total soil N content were determined for each installation.

• Douglas-fir productivity for each installation was measured using King's site index.

• 76,000 data points were mapped to estimate climate, elevation, and soil data.

• Soil and site productivity were predicted for the data points.

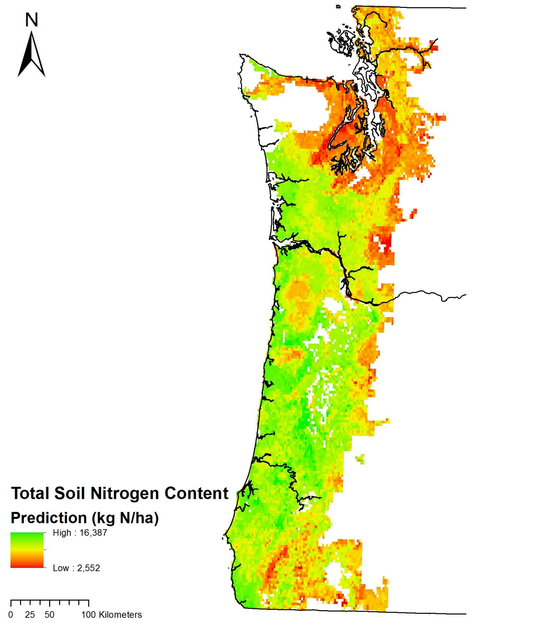

Figure 2. Prediction of total soil nitrogen contents.

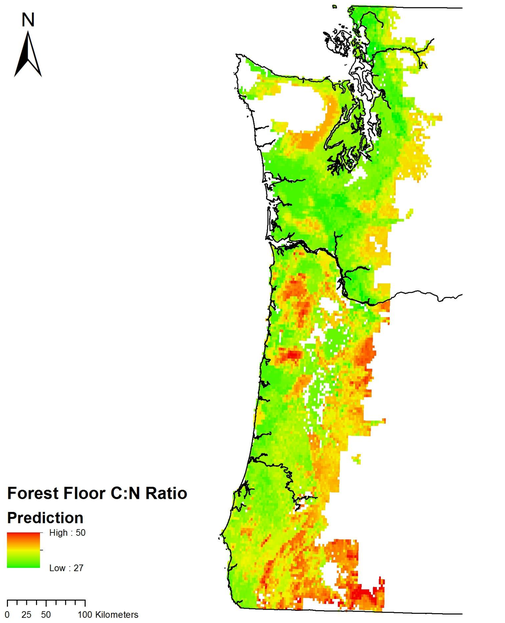

Figure 3. Forest floor carbon to nitrogen ratio predictions.

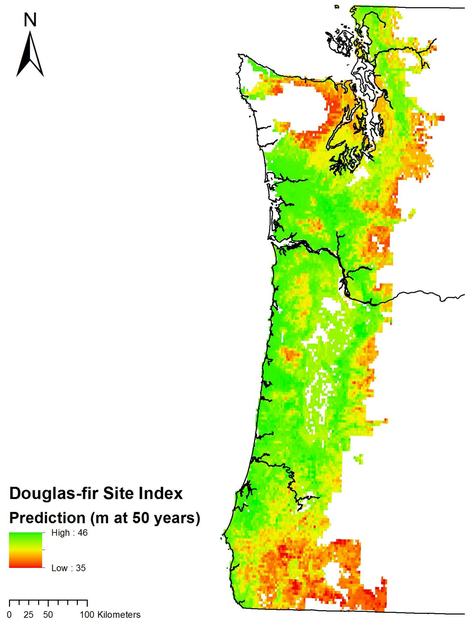

Figure 4. Estimations of Douglas-fir site index.

Statistics:

• Boosted regression trees are a combination of regression trees and machine learning.

• 1500 regression trees are produced to explain the deviance in the response variable and are combined to form the final model.

• Partial dependence plots define the effect of the predictor variables on the response variable through a fitted function (Table 1).

Results:

• Soil N contents were greater in the Oregon lowlands and lowest in the Cascade Range due to higher clay and organic matter contents and higher available water (Figure 2).

  • Related to total soil carbon contents.

• Forest floor C:N ratios were highest in Oregon igneous soils and regions with lower winter temperatures and greater precipitation as snow (Figure 3).

  • Higher mineralization in areas of low forest floor C:N ratios.

• Douglas-fir site index estimations correspond with total soil N and forest floor C:N maps because of the shared predictors between soil and site productivity (Figure 4).