Continuing Project

Stand and Tree Responses to Late-Rotation Fertilization

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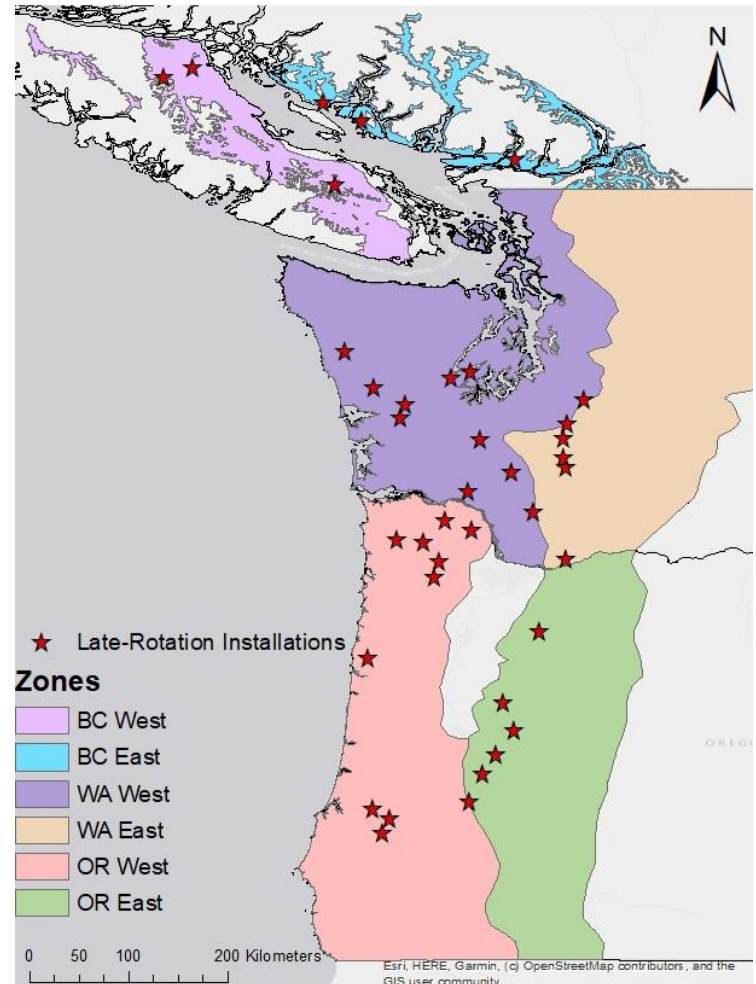Eric Turnblom, Kim Littke, Jason Cross, Mason Patterson, and Rob Harrison (UW)

Kim Littke

Project Overview

Objectives

- Determine the average, area-based volume response to late-rotation fertilization

- Estimate the regional economic returns of late-rotation fertilization

- Assess the ability to predict response to fertilization using plant root simulator (PRS) probes

- Produce models to improve predictions of Douglas-fir fertilizer response

★ Late-Rotation Installations

Zones
- BC West
- BC East
- WA West
- WA East
- OR West
- OR East

0 50 100   200 Kilometers

Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

Methods

- Established randomly located paired-plot Douglas-fir installations in BC, WA, and OR

- Installed Plant Root Simulator probes prior to fertilization

- Fertilized with urea at 200 lb N/acre

- Measure fertilizer response over 2-8 years and at harvest

  - 34 installations measured for four-year response

  - 29/33 installations measured for six-year response

  - 4 replacement installations were established Spring 2024
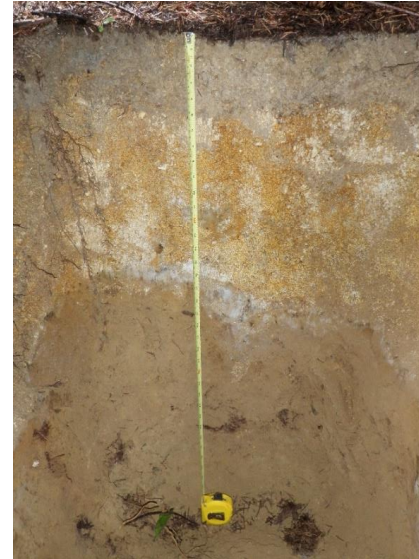
Anion PRS Probe

adsorbs:
NO_3^-, $H_2PO_4^-$, SO_4^{2-}, micros, etc.

Anion Resin Quaternary $R-NH_4^+$
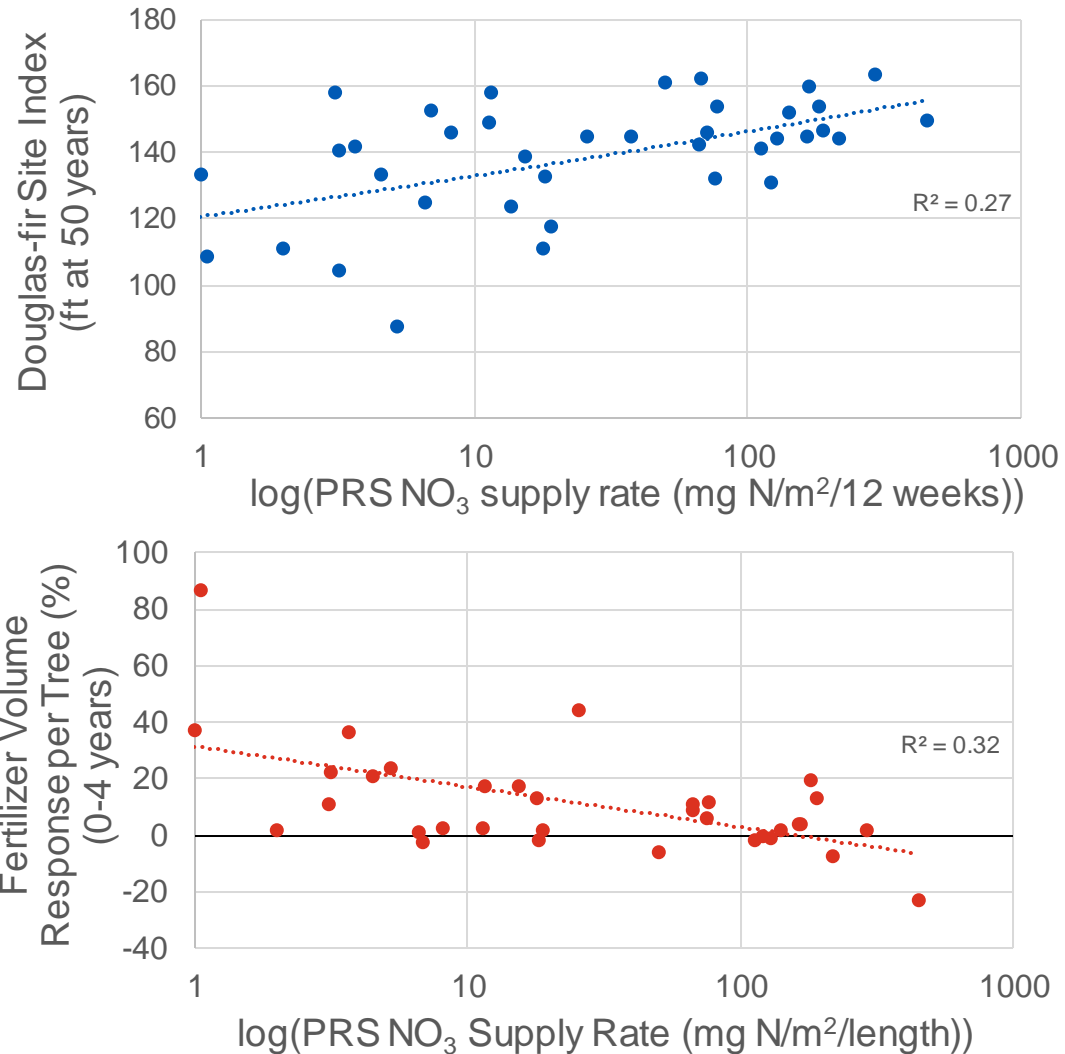
Cation PRS Probe

adsorbs:
NH_4^+, K^+, Ca^{2+}, Mg^{2+}, etc.

Cation Resin sulfonic acid $R-SO_3^-$

Major Findings

- Plant Root Simulator probe NO_3 supply rate positively related to Douglas-fir site index

- PRS NO_3 is negatively related to fertilizer response

- PRS NO_3 is a better predictor of soil N availability, site productivity, and fertilizer response than other N variables
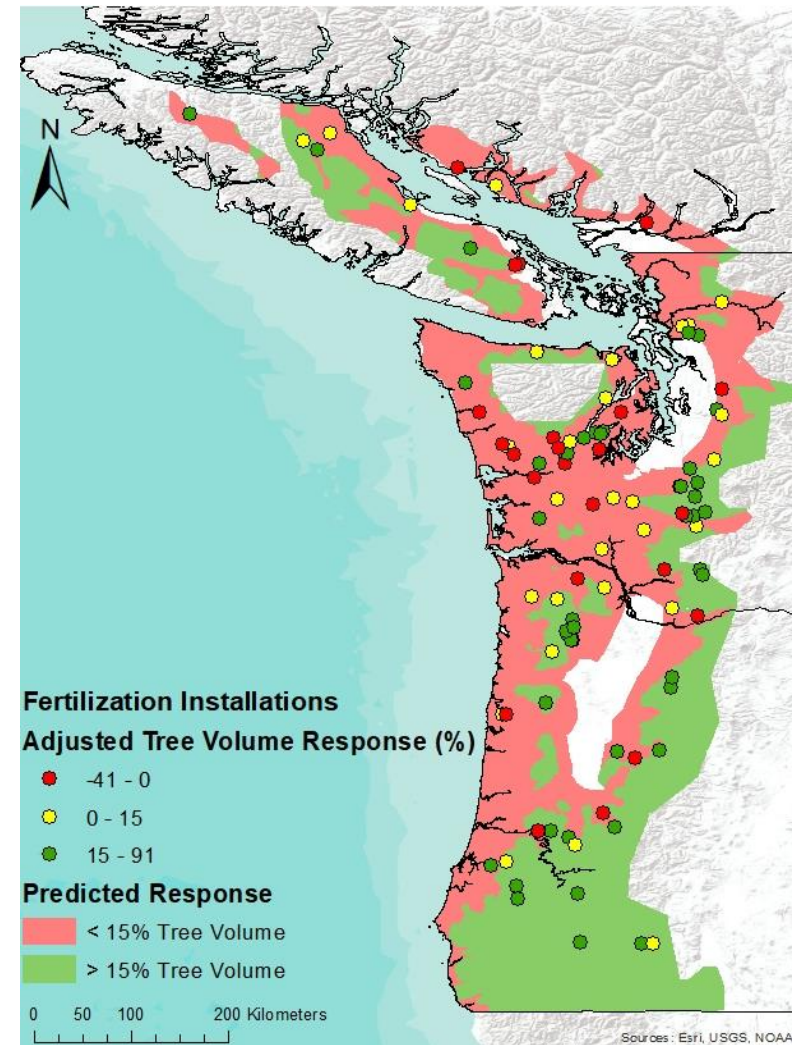

Douglas-fir Site Index (ft at 50 years) vs log(PRS NO_3 supply rate (mg N/m^2/12 weeks)), $R^2 = 0.27$

Fertilizer Volume Response per Tree (%) (0-4 years) vs log(PRS NO_3 Supply Rate (mg N/m^2/length)), $R^2 = 0.32$

Major Findings

- Predicted 0–4 year tree volume response of Paired-Tree and Late-Rotation installations using boosted regression tree model

Model	Range	Relative Influence (%)
Elevation	>1,600 ft	40
Site Index	<120 ft	36
July Precipitation	<0.7 in	19
April Temperature	<47°F	5

- Map heavily influenced by elevation and site index
  - Selected predicted response ± 15% (mean=11%)
  - Greater response in predicted response regions in test dataset (RFNRP installations)
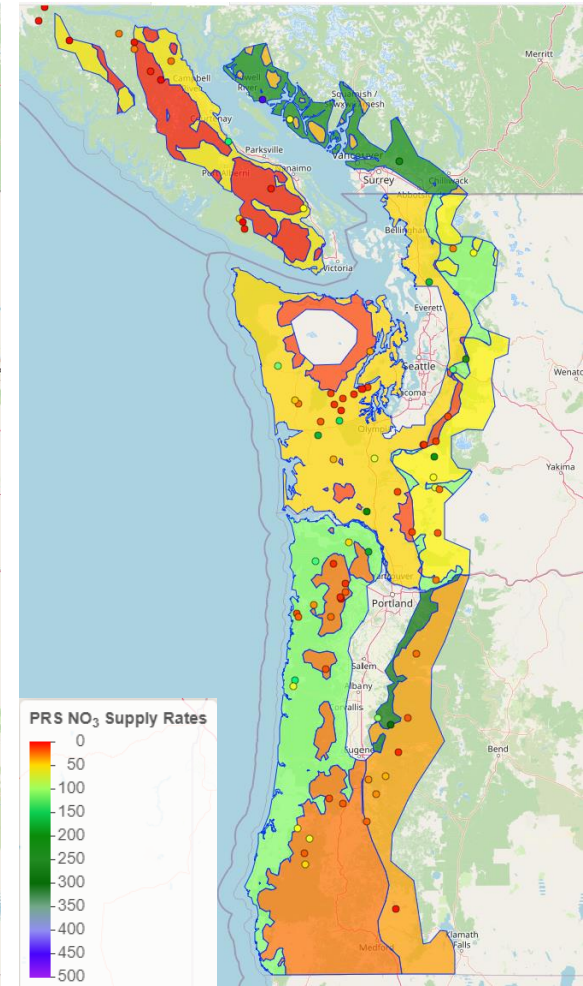 - Lower N availability within predicted response regions

Fertilization Installations
Adjusted Tree Volume Response (%)
- 🔴 −41 - 0
- 🟡 0 - 15
- 🟢 15 - 91

Predicted Response
- 🟥 < 15% Tree Volume
- 🟩 > 15% Tree Volume
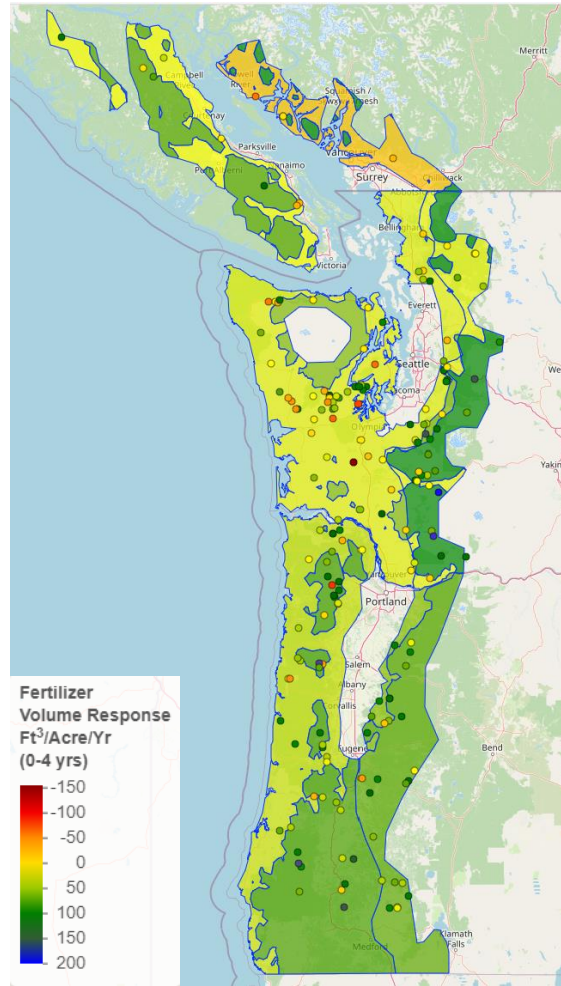
0   50   100   200 Kilometers

Sources : Esri, USGS, NOAA

Major Findings

- Produced online Shiny map of regional fertilizer response

- Response zones: Intersected predicted response regions with Late-Rotation zones

- Determined mean response per tree and per area within each response zone from 3 studies

- Alternate maps to show PRS NO$_3$ on response map

- Upload and download points to determine mean expected response

Douglas-fir Fertilizer Response Map
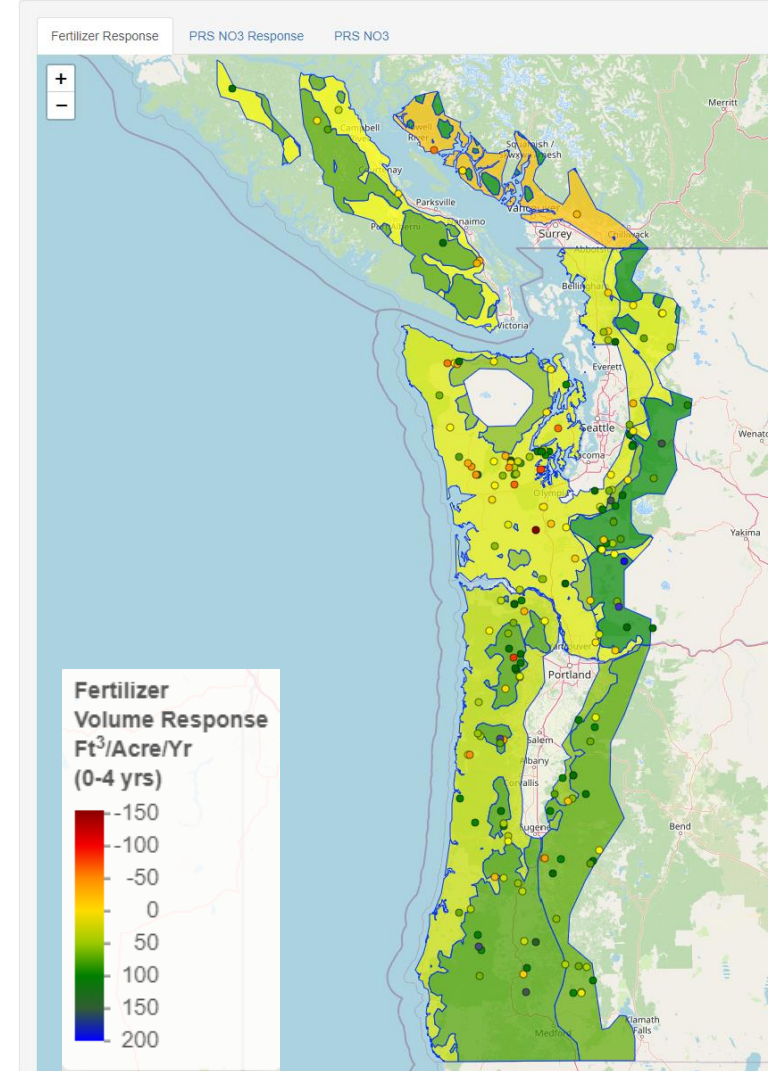
Recommendations

- Select stands for fertilization based on best responding response zones
    - Responsive zones in BC West, WA East, OR West, and OR East
    - Non-responsive zones in WA and OR East yielded better than expected response
    - Greatest response zones were also low in PRS NO_3

Fertilizer Volume Response Ft³/Acre/Yr (0-4 yrs)
-150
-100
-50
0
50
100
150
200

PRS NO_3 Supply Rates
0
50
100
150
200
250
300
350
400
450
500

Deliverables

- 38 Late-Rotation Douglas-fir installations
- Soil, tree, and PRS probe nutrient data collected across the coastal Pacific Northwest
- Published article:
  - Littke, K.M., Holub, S.M., Bremer, E., Turnblom, E.C. 2024. Utility of *in situ* Ion Exchange Membranes to Assess Nutrient Availability, Productivity, and Fertilizer Response of Coastal Douglas-fir of the Pacific Northwest. Soil Sci. Soc. Am. J. 1-19.
- Manuscript planned:
  - Economic analysis of regional fertilization of late-rotation stands
- Online Shiny map to guide fertilizer stand selection
- Inclusion of response data into growth models

Company Benefits

- Average area-based volume response in six distinct zones

- Examination into the economics of late-rotation fertilization

- Greater understanding of nutrient availability in predicting fertilizer response

- Online map to determine estimated fertilizer response