Continuing Project

Physiologic Response to Commercial Fertilization Programs in Pacific Northwest Forest Plantations CAFS 20.84

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Justification

- Fertilizer response is highly variable in the Pacific Northwest mostly due to N availability
  - Climate, soil, and stand conditions affect the magnitude and continuation of response
- Fertilization causes a temporary increase in photosynthetic rate and water use efficiency, but long-term response requires an increase in leaf area
  - Stands that cannot increase leaf area will likely not respond to fertilization even if N is limiting
- Measurements of physiologic processes through C and O isotope ratios should further explain fertilizer response and guide future fertilization decisions

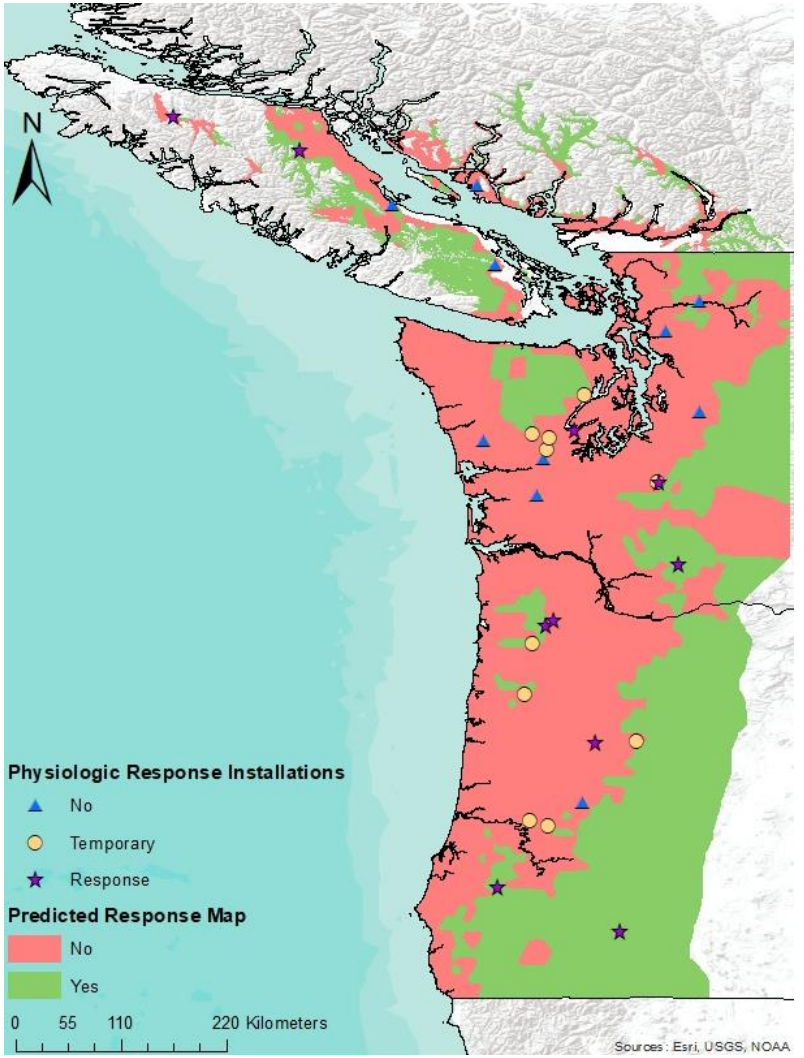
Objectives

Understand physiological patterns of response in fertilized Douglas-fir plantations

1. Investigate mechanisms of physiologic processes under various climate, soil, and stand conditions
2. Develop regional silvicultural guidelines for commercial forest operations
3. Provide data to inform changes in silvicultural treatments due to future climate change

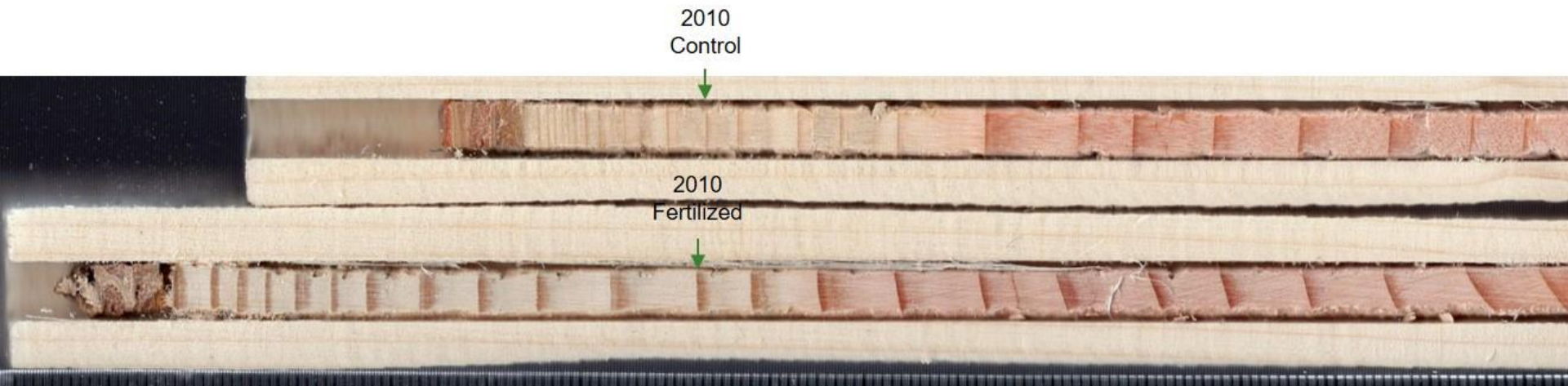
Methods

- Utilize remaining SMC Paired-tree installations
- Select a subset of responding, temporary response, and non-responding installations
  - 10 installations from each response type
- Installed Plant Root Simulator probes under control and fertilized trees
- Foliar N and needle area measured two years after fertilization



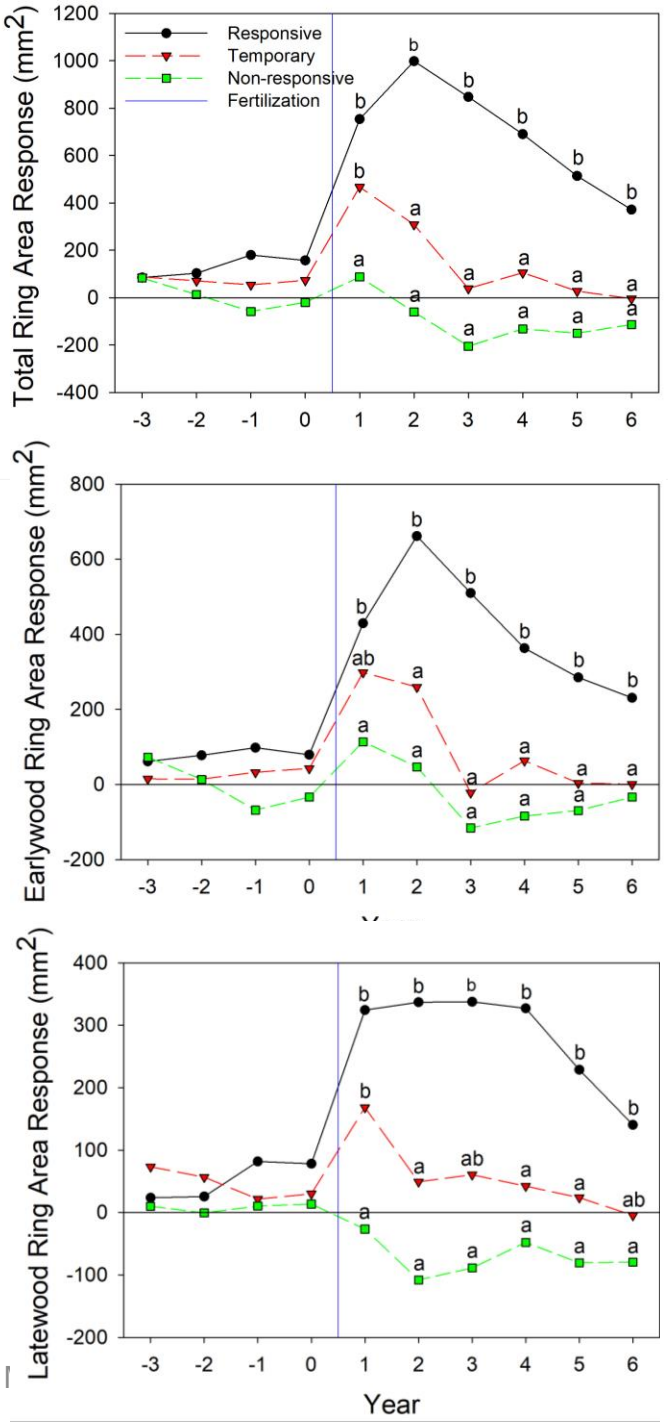
Methods

- Dated and measured earlywood and latewood from 870 trees
- 564 cores split into EW/LW 4 years prior to and 6 years post fertilization
  - Composite by installation, treatment, component, and year
- Isotopic composition ($\delta^{13}C$ and $\delta^{18}O$) analyzed at Columbia University
  - $\delta^{13}C$ describes the effect of fertilization on photosynthesis and intrinsic water use efficiency
  - $\delta^{18}O$ is negatively related to stomatal conductance
  - 18/30 installations measured for δ13C
  - 15/30 installations measured for δ18O



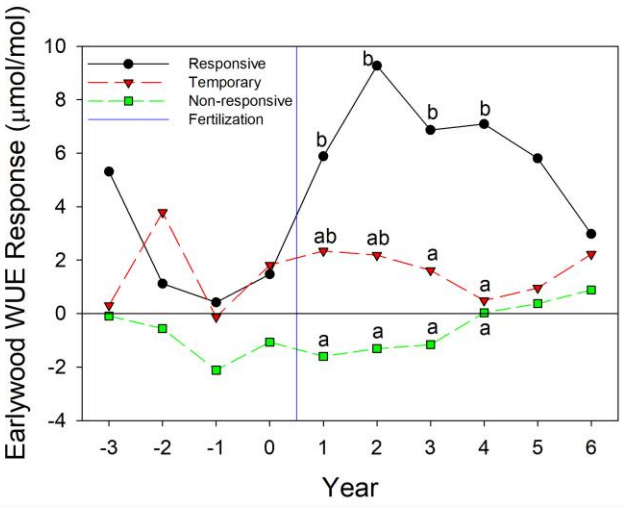
Major Findings

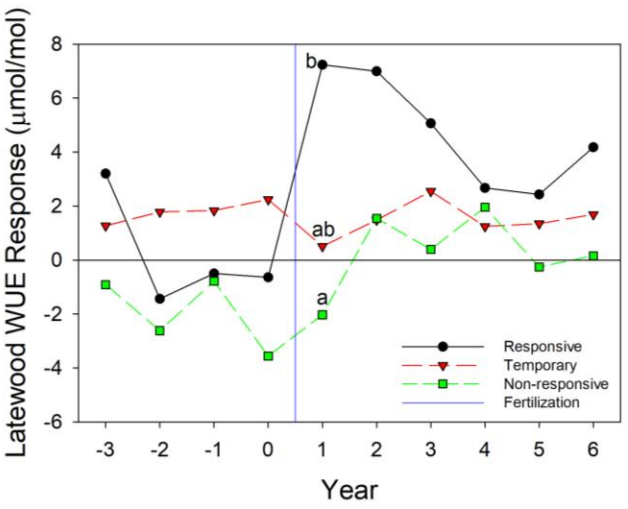
- 30/30 installations measured for ring area
- Responsive (4+ years) installations responded more in ring area than temporary response (0-2 years) and non-responding installations from 2-6 years
    - Temporary responsive installations only grew higher earlywood and latewood in the first year after fertilization
- Earlywood response peaked at 2 years after fertilization
- Latewood growth in responders stayed high for 4 years after fertilization then decreased in years 5 and 6

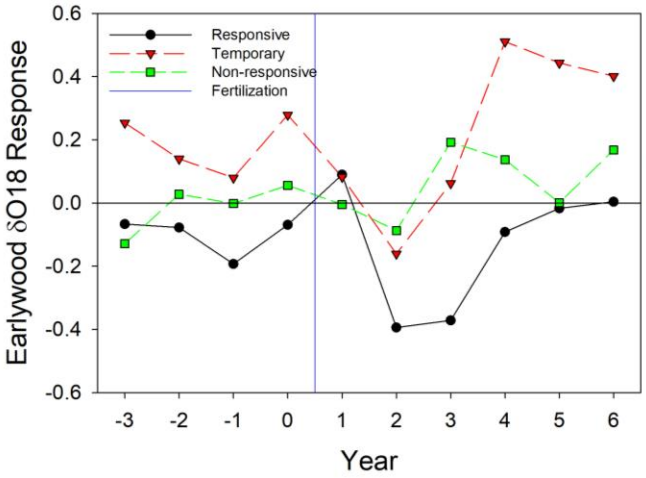


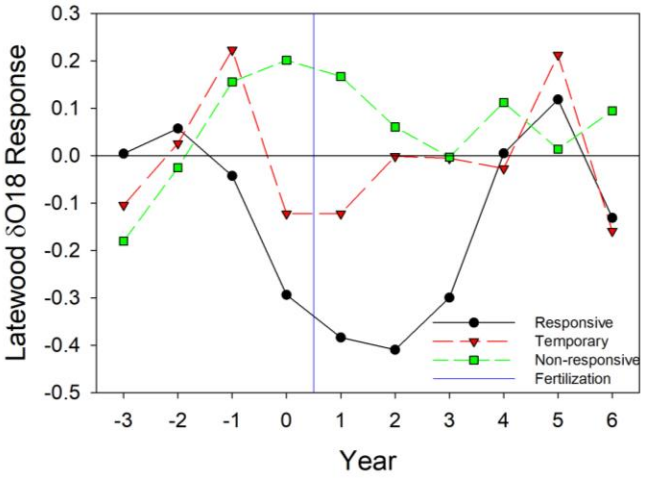
Major Findings

- 18 installations measured
- Responsive installations increased earlywood WUE more than non-responsive installations for four years
  - Latewood WUE response was only greater in responders in year 1
- There were no significant differences in δO18 between response types
  - Increasing δO18 in temporary responders after year 4 suggests a decrease in stomatal conductance (drought)



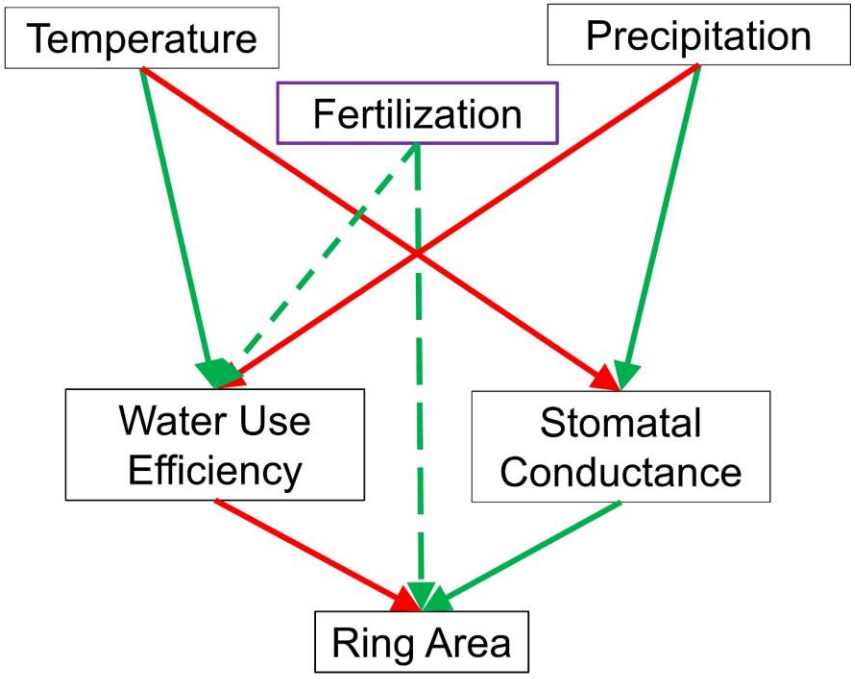






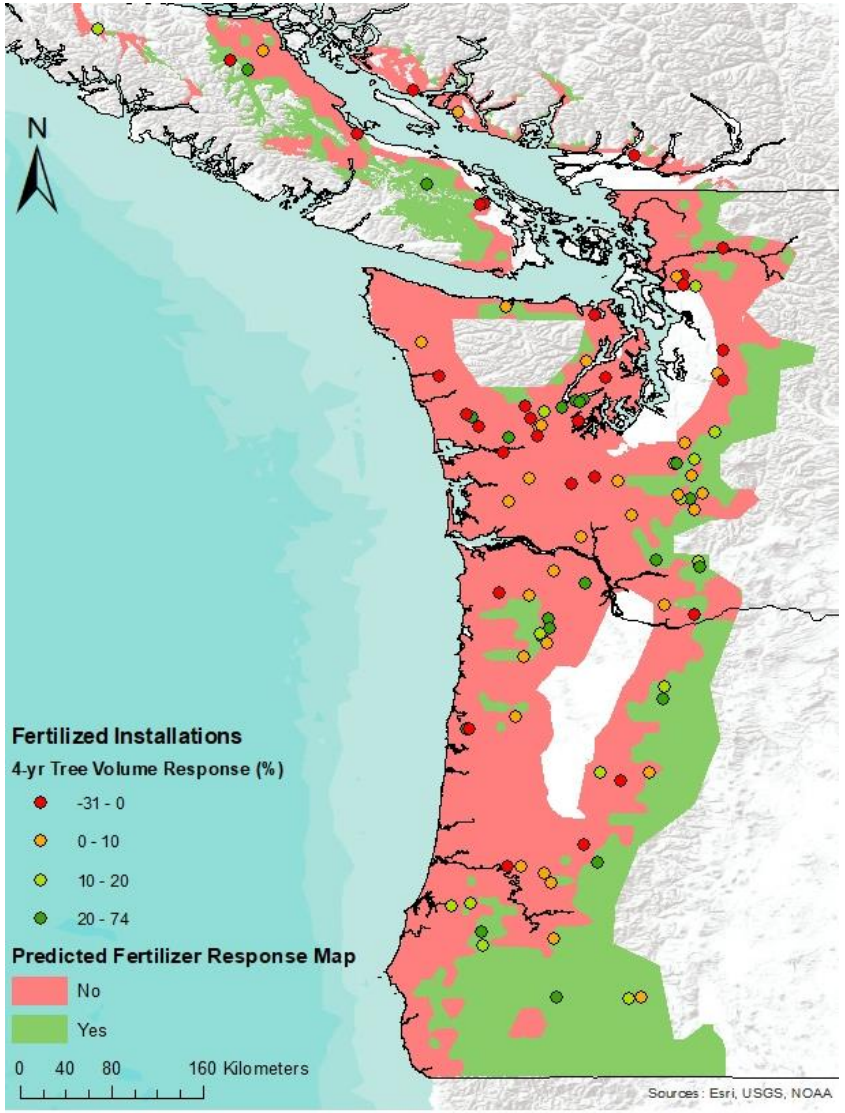
Major Findings

- WUE ($\frac{photosynthesis}{stomatal\ conductance}$) and stomatal conductance ($-\delta O18$) are oppositely related to temperature and precipitation
  - Greater WUE in warmer, drier years is due to lower stomatal conductance and not an increase in photosynthesis
- Greatest ring area growth in colder and wetter years due to greater stomatal conductance
- Fertilization increased WUE (photosynthesis) and ring area in responsive installations
  - Greater response in cool, wet years
  - Fertilization does not appear to be increasing drought on responding installations
  - Potential for increasing drought in temporary response installations



Recommendations

- Prioritize fertilization on stands with long-term response
  - High elevation
  - Low site index
  - Cold Spring temperatures
  - Low Summer precipitation
  - Southern latitudes



Deliverables

- Relationships between biogeoclimatic variables and physiologic response to N fertilization
- Proposed silviculture alternatives under potential changes in future climate
- Three peer-reviewed publications that reflect each project objective
- A study design that can be applied to national forests through the Center for Advanced Forestry Systems

Company Benefits

- Improved fertilization and silviculture recommendations for Douglas-fir plantations based on physiologic response
- Recommendations for silviculture under future climate scenarios