Management Questions – Science Answers:

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Red alder nutrition
Some updates on effects of fertilizing young plantations

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Red alder has valuable and uncommon suite of characteristics:

- contributes to habitat diversity in a conifer-dominated landscape
- fixes atmospheric N and adds to soil over time - important for maintaining forest productivity
- immune to laminated root rot *Phellinus weirii* – alternative species for infected sites
- potentially rapid growth
- has wood properties that are desirable and uniform
- can produce a variety of value-added wood products in a relatively short period.

Caveats learned through both short and long-term research:

- Alder has to be planted on the right site – sensitive to growing season moisture stress
- Stand management is critical for high-diameter clear logs with minimal defect
- Critical silviculture decisions and investments come early in stand / plantation growth.

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- Rotations may be as short as 25-30 years

Climate change effects on alder distribution and growth

- may affect site conditions, disturbance, and distribution
- e.g., +72% habitat gain for red alder by 2085 (Hamann and Wang 2006 Ecology 87:2773)

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Uncertainty about future might argue for more attention to managing rapid growth, short-rotation species such as red alder

Nutrition is an important determinant of forest productivity

- can address through:
  (a) site selection
  (b) soil protection or manipulation during and after harvest
  (c) addition of deficient mineral elements after planting

Fertilization – need to:

- identify deficient element(s) and add:
  - on appropriate sites
  - at appropriate rates and in appropriate form
  - at the appropriate time during plantation/stand growth

Red alder nutrition research background (BC)

Short-term studies (< 3 years post-treatment):

- P deficiencies can limit the growth of young (<1 year of planting) alder on E, S Vancouver Island
- Other elements – no conclusive evidence, but…
- Growth responses to P often pronounced in soils from sites classified as rich - very rich
- May be possible to screen sites for low P supply using standard assays of extractible P from soil
- Haven't seen consistent response to P additions in older (> 2 years post-planting) plantations

Two big questions:

1. How long do fertilized trees stay bigger (and how is wood distributed among stems in a plantation)?

2. How might site moisture availability affect growth response to P additions?

    - **Seedlings may respond more to P additions in moderately wet or dry compared with mesic soils**

        Why?

Three sets of field experiments to discuss:

- Single-tree plot experiments
- P additions at planting on moist sites
- P additions on a drier site

How long have effects of P additions at planting persisted?

Persisting effects of nutrient additions in single-tree plot experiments

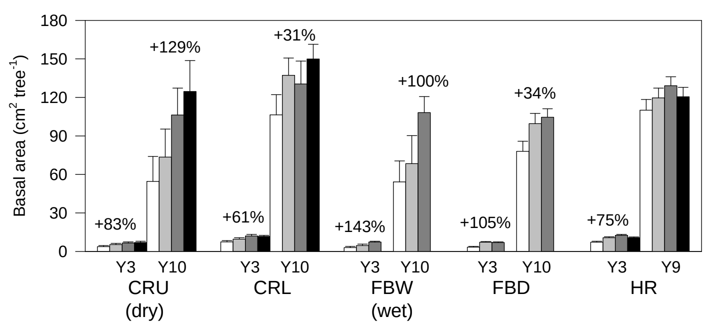
- Remeasured single-tree plot fertilization experiments at 5 sites on E Vancouver Island.
- Sites near Cowie Creek, Campbell River Airport, Mohun Creek (Snowden Road)
- Plantations were established in 1997 (fertilized spring 1998) and 1999 (fertilized spring 1999)
- Classified as good, medium, or poor for alder growth
- Fertilized with P (0, 10, 20, 30 g P/tree) and / or blend of other elements
- Three-year growth responses: all 5 responded to P additions, not other elements.
- Re-measured in fall 2007; 10-year response for 4 studies and 9th for the fifth site

Results

- Effects on dbh and ba were significant through 10 years at 4 sites
- Basal area of unfertilized trees varied two-fold across sites
- Effect of added P on growth was greatest on the trees in the “poor” (wetter and drier) sites
- Linear response to P suggested higher rates might elicit larger response

Issues with interpretation:

- Unknown amount of mortality between years 3 and 9/10 – probably highest at dry and wet sites
- Unknown amount of growing space around each tree at either measurement time

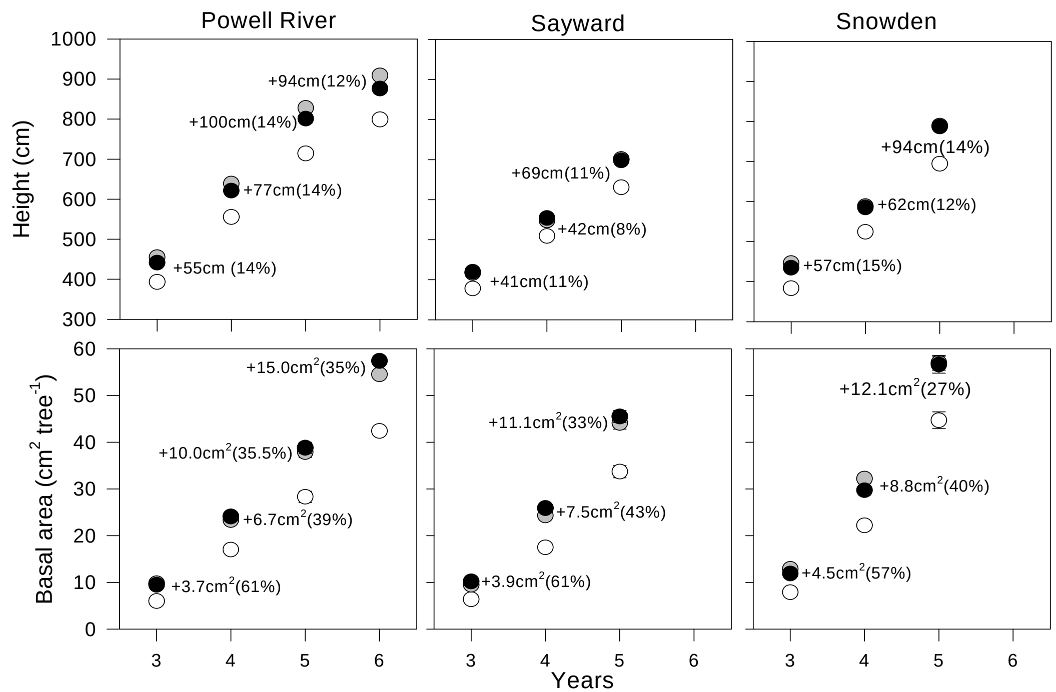


Continuing responses on moist sites to fertilization at planting

Established experiments at 3 “medium - good” productivity sites in plantations established by NW Hardwoods

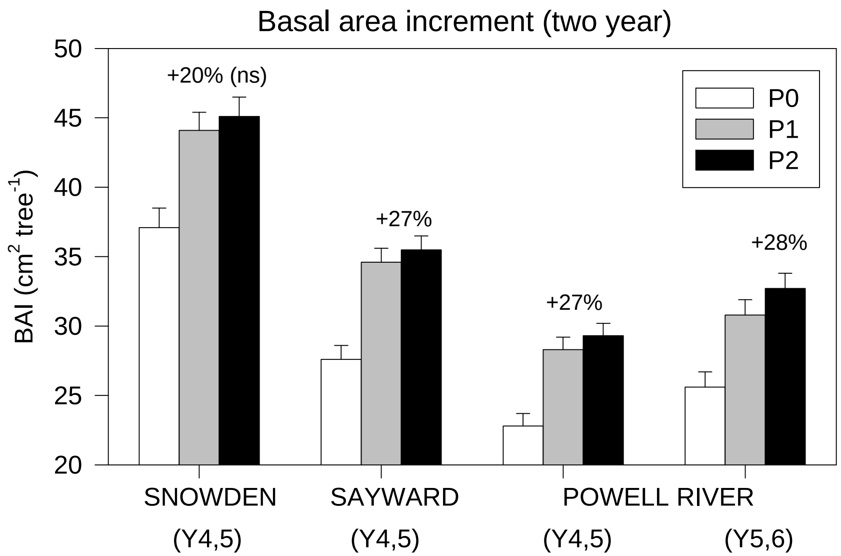
- Near Powell River (2004) Campbell River (Snowden Road) and Sayward Jct (both 2005)
- Added P only: 0,30,60 g P / tree
- Multi-tree treatment plots – 25m x 25m with a central circular measurement plot with ca. 30 trees
- Measured every year - foliar elemental analysis in yrs 1-3 used to confirm deficiencies

- Effects of P additions significant in year 1; P1 and P2 do not differ as yet
- Through 3 years- responses were similar – 11-15% (41-57cm for ht) and 57-61% (3.7-4.5 cm^2/tree)for basal area
- Over 6 yrs (PR) and 5 yrs for Sayward, absolute difference between P0 and P1,P2 increasing for basal area



Basal area increment (BAI) for years 4-5 at all three sites and for years 4-5, 5-6 at Powell River

- P additions appear to be increasing BAI at Sayward, Powell River
- Magnitude of increase appears similar for Snowden and Sayward, but is not statistically significant at Snowden

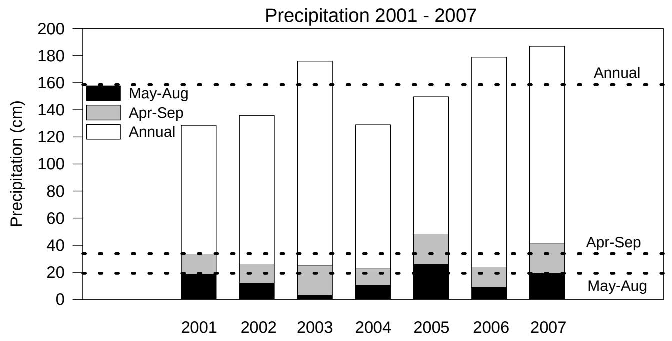


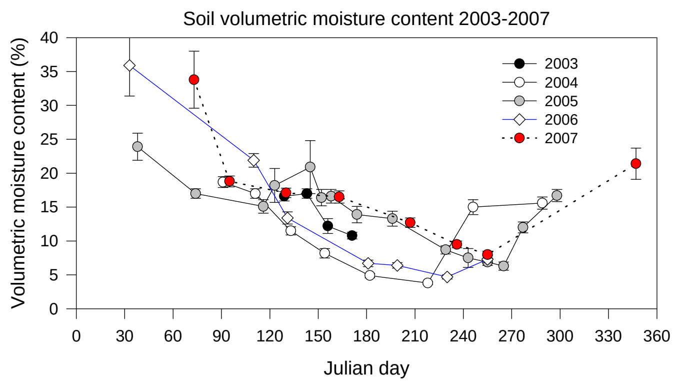
Continuing responses to P additions on a drier site

- Moderately-dry *Phellinus*-infected site near Bowser
- Harvested 1998; stumped; planted with red alder in fall 1999, followed by fill-plant in spring 2001
- Soil: sand-loamy sand, high coarse fragment content, duric horizon at 60-90cm depth
- 45m x 45m treatment plots with inner 25m x 25m measurement plot; ca. 90 trees/ plot to begin
- Considerable amount of bitter cherry which sprouted beginning in 2000
- Initial P additions were 0, 15, 30g P / tree in spring 2001; P also added in subsequent years to maintain differences in foliar P

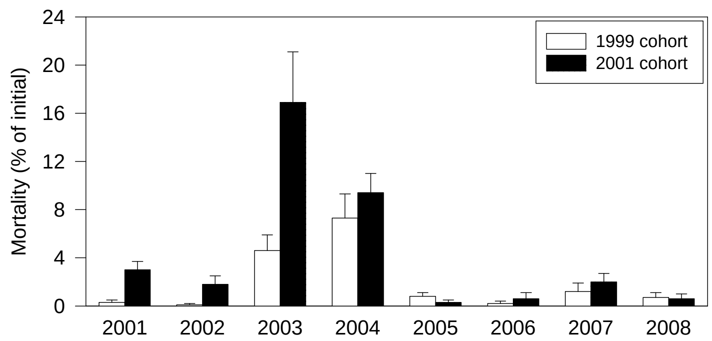
Precipitation and soil moisture contents at McColl are variable and may affect survival and growth

• growing season precipitation low in 2003, 2004, 2006; higher in 2005, 2007
• soil moisture is low in 2004, 2006; high in 2005 and 2007
•2008 precipitation may have been lower than 2007 or 2009



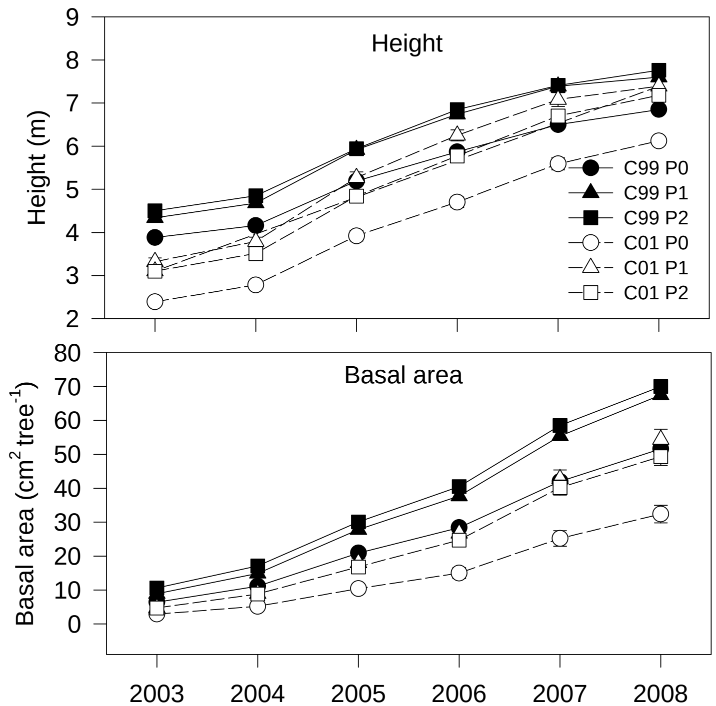


• Mortality not affected by P additions
• Mortality high in 2003-04 for 2001 cohort; 2004 for 1999 cohort
• Cumulative mortality greater in 2001 cohort



Time trend of height and basal area through 2008

- Height differences with P application largely established early on
- Basal area differences may be increasing over time or at least persisting
- Effect of P additions on height; (possibly basal area) appears greater for the 2001 cohort (C01)



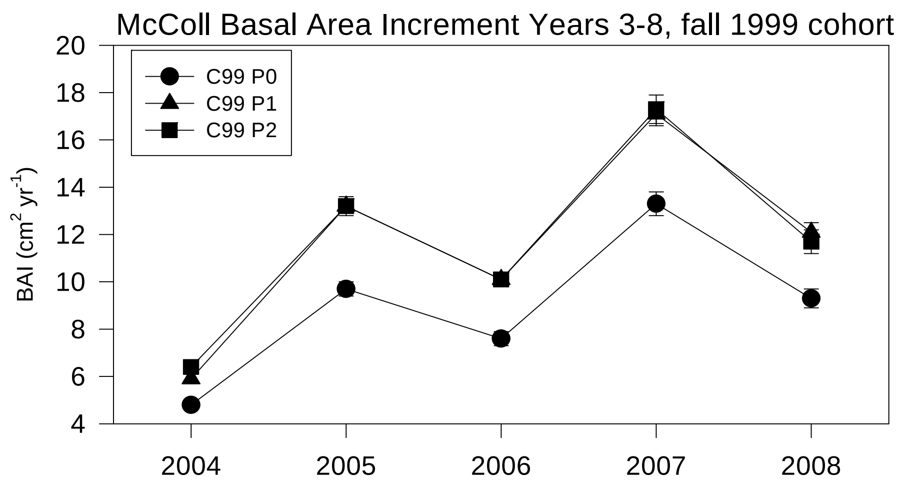
Temporal change in BAI by P treatment (Only 1999 cohort shown)

• BAI increases with P addition; in 2008, absolute and % increase was greater in 2001 cohort than 1999 cohort

• BAI goes up and down – associated with annual variation in growing season precipitation and soil moisture?

• Absolute increase in BAI with P addition may be greater in wetter years

• However, there have been no apparent effect of P additions on survival



How do P additions affect growth of crop tree versus all trees?

For 2008 data: compared response of all trees (ca. 1100 tph) vs crop trees (256 tph)

Basal area

All trees: P increased 18.3cm^2 / tree (31%) (*P*=0.029)
Crop trees: P increased 18.4cm^2 / tree (22%) (*P*=0.111)

DBH

All trees: P increased 1.5cm (18%) (*P*=0.018)
Crop trees: P increased 1.1cm (11%) (P=0.120)

Through 8 years, the effect of P additions appears similar to or less for crop trees

Some ongoing questions of interest

- How much longer will effects of P fertilization persist?
- How will mortality and growth patterns change with further stand development?
- Will P fertilization affect crown characteristics and wood quality?
- How will P-fertilized trees respond to dry summers as trees get larger?
- Will early fertilization with P affect rates of soil C and N accumulation?

Resources

Brown and Courtin. 2007. Phosphorus additions increase the early growth of red alder (*Alnus rubra* Bong.) on Vancouver Island. West. J. Applied Forestry 22:116-122 (discusses early growth responses in single-tree plot fertilization experiments)

Brown and Courtin. 2003. Effects of phosphorus fertilization on the early growth of red alder plantations. BC Min For Coast Forest Region Res. Ext. Note EN019 (discusses establishment of McColl experiment)

Courtin et al. 2002. Red alder management trials in the Vancouver Forest Region. BC Min For Vancouver Forest Region Res. Ext. Note EN016 (overview of site considerations and stand management experiments on Vancouver Island)

Deal and Harrington. 2006. Red Alder: a state of knowledge. USDA Forest Service Gen Tech Rep PNW-GTR-669

Hardwood Silviculture Cooperative http://www.cof.orst.edu/coops/hsc

Puettmann et al. 1993. Density management guide for red alder. Ore. St. University Coll. Of Forestry Forest Res. Lab. Res. Contrib. 2