I. Mineral Nutrition and Fertilization of Alder

It Fixes Nitrogen…So, What's the Problem?

II. Bitter Cherry: How Big, How Old, and What Can You Do With It?

Kevin Brown, PhD, PAg, RPBio
KR Brown and Associates
Victoria BC

CfBC Member

Red Alder:

- Why is nutrition important?
- What elements limit alder growth?
- How much does growth response to added nutrients vary with site?
- When and how might nutrients be added?

Pacific Northwest forests

- N deficiencies typically limit productivity
- Red alder fixes atmospheric N_2
- What's the problem?

Fertilizer Research 27: 129–140, 1991.

Forest fertilization research and practice in the Pacific Northwest

H.N. Chappell[1], D.W. Cole[1], S.P. Gessel[1] & R.B. Walker[2]
[1] *College of Forest Resources and* [2] *Department of Botany, University of Washington, Seattle, WA 98195, USA*

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Key words: Douglas-fir, nitrogen, mineral cycling, growth and yield

Abstract

Forest managers in the Pacific Northwest (PNW) use fertilization as a means to increase timber yields in managed stands. Information on the biological basis for nutrient amendments and stand growth responses to fertilization is required to effectively use fertilization as a silvicultural tool, and research programs in mineral cycling and forest nutrition have been underway in the region for about four decades.

Most PNW Douglas-fir forest sites are nitrogen deficient. Mineral cycling research has shown high C/N ratios and low nitrification rates for soils in the region.

Research and development projects in the Pacific Northwest have produced an information base that is used to select sites and stands for fertilization and to forecast growth after treatment. Much of the basis for operational fertilization programs in western Oregon and Washington comes from cooperative research programs; current activities for these programs are directed toward improving site-specific response information.

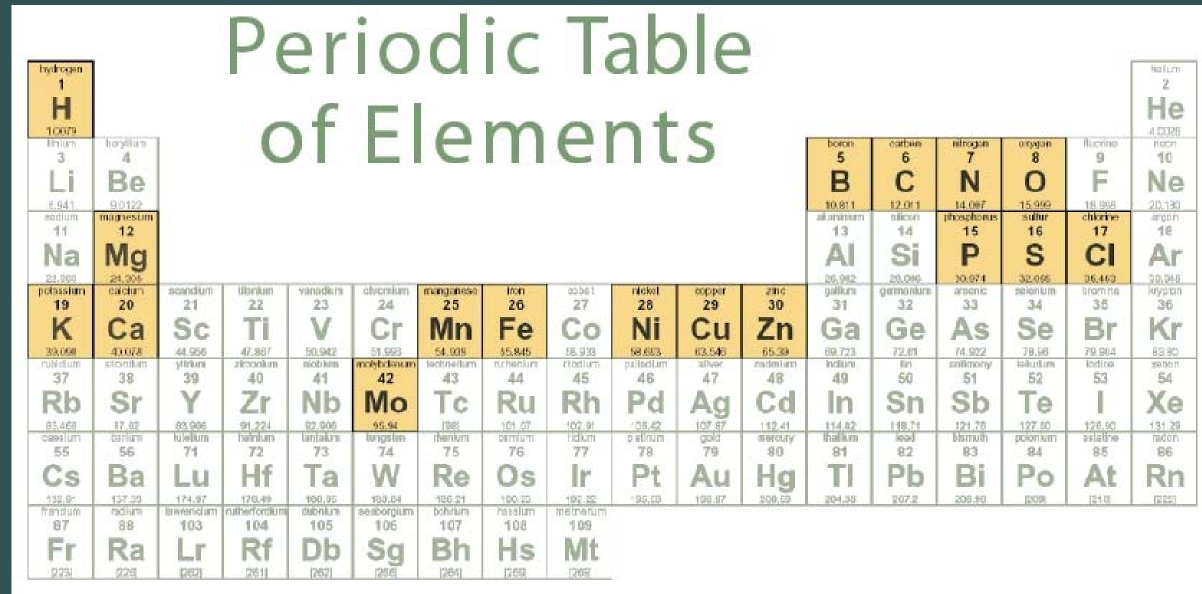
Forest fertilization in the Pacific Northwest has become a silvicultural practice of major significance over the past two decades. Forest industry and government organizations managing forest lands in western Oregon and Washington apply nitrogen fertilizer to Douglas-fir stands over a range of soil and stand types (operational fertilization of other species is minor). About 50,000 to 55,000 ha are fertilized each year, and future programs will likely be of similar magnitude. Most current plans for management regimes including fertilization call for multiple applications.

Introduction

The practice of forest fertilization has been adopted by forest management organizations worldwide as a biologically sound and cost-effective means to increase tree and stand growth. Fertilization programs are well developed for forests around the world, including operations in Australia, New Zealand, South Africa, and several forest regions in Europe and North America [2, 4, 42, 55, 64, 69]. Many programs are directed at ameliorating nutrient deficiencies which adversely affect forest plantation establishment, while others are for the purpose of enhancing growth rates in natural and man-made forests.

The basis for operational fertilization programs is found in the substantial information base developed by forest nutrition research projects, including several large cooperative projects in North America. In the Pacific Northwest (PNW) region of the United States and Canada, research in forest nutrition and fertilization began about four decades ago, and the first operational applications of fertilizer occurred in the early 1960s. Pacific Northwest fertilization programs have been primarily directed at enhancing stand growth since nutrient deficiencies are not severe enough to impede establishment

15 essential mineral nutrients



Plant requirements:

"Macro" "Micro"

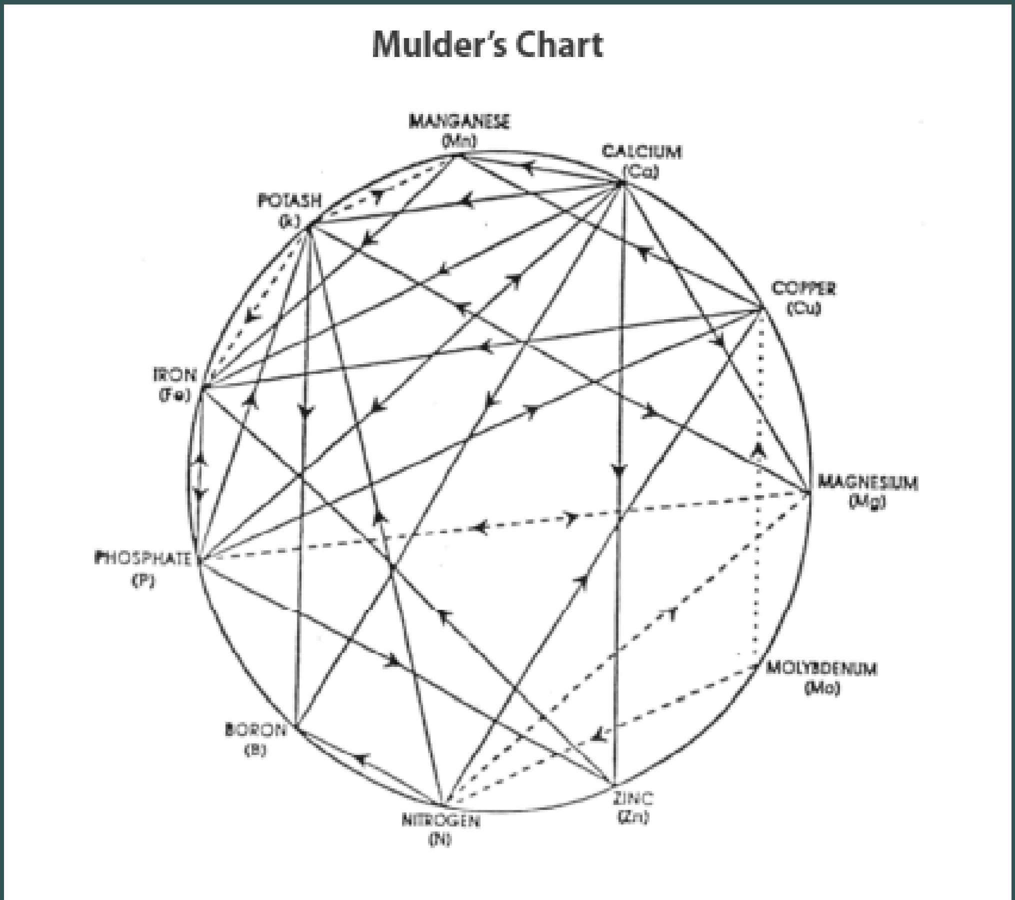
N > K > P > Ca = Mg = S >> Fe B Cu Zn Mn Mo Cl Si Co

Mineral nutrients don't act in isolation:

Adding one can affect another, e.g.:

- adding S can decrease Mo uptake
- adding Mo can increase N uptake
- adding P can decrease Zn uptake

PNW- high inputs of N can cause loss of soil cations, expose deficiencies of K, S, and P (Douglas-fir, hemlock, poplar)



Nutrient imbalance can reduce growth, increase tree susceptibility to disease, frost damage

Red alder – unique set of characteristics

Potentially fast-growing species

N_2-fixer: needs

- energy (as carbon)
- nutrients for C metabolism and growth
- Mo and Co for N_2-fixation

Deciduous:

- needs growing-season moisture
- drought may reduce P uptake

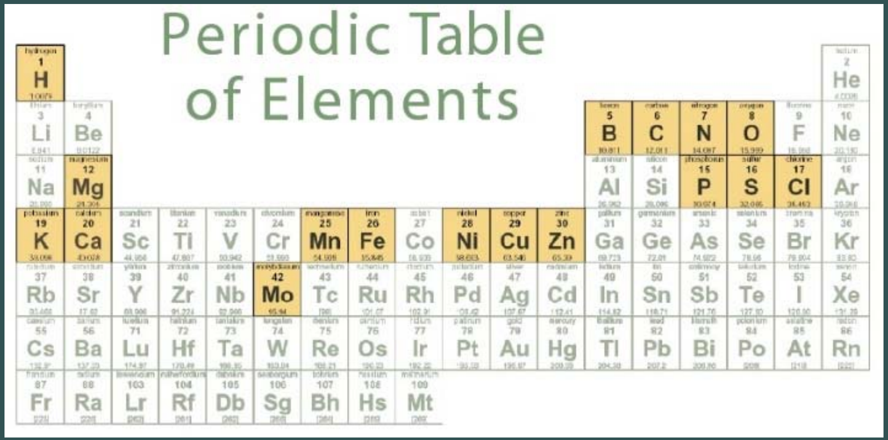
What nutrients are deficient?

What soils and sites?

What are appropriate rates?

When to add ? How long will the effect last?

Alternatives?



Identifying deficiencies

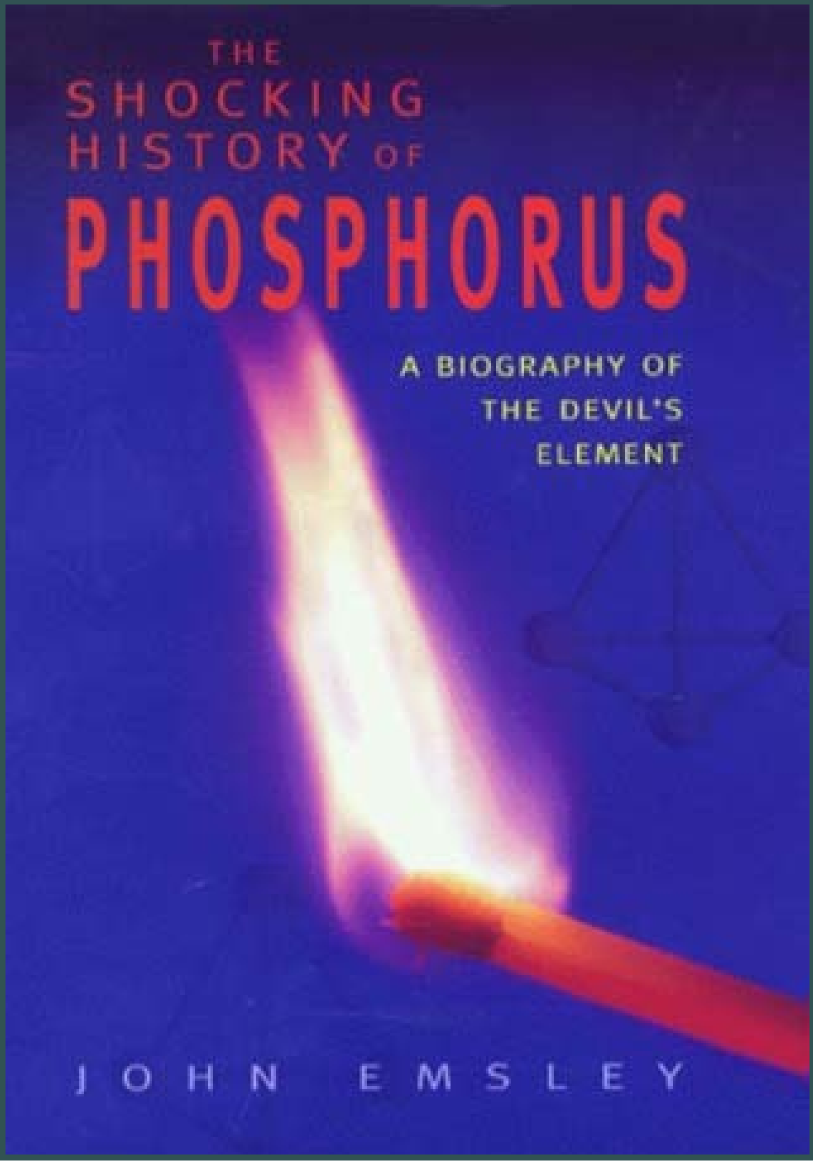
"Early" Studies

Correlative:
- Connie Harrington 1986 (WA, OR)
- Paul Courtin 1992 (SW British Columbia)
- Harrington and Courtin 1994

Experimental:
- M.A. Radwan and Dean DeBell 1994
- Dale Cole and co-workers UW 1980s-2000s

Low phosphorus level often associated with reduced growth

Other elements-not so much



Experimental Studies on Vancouver Island

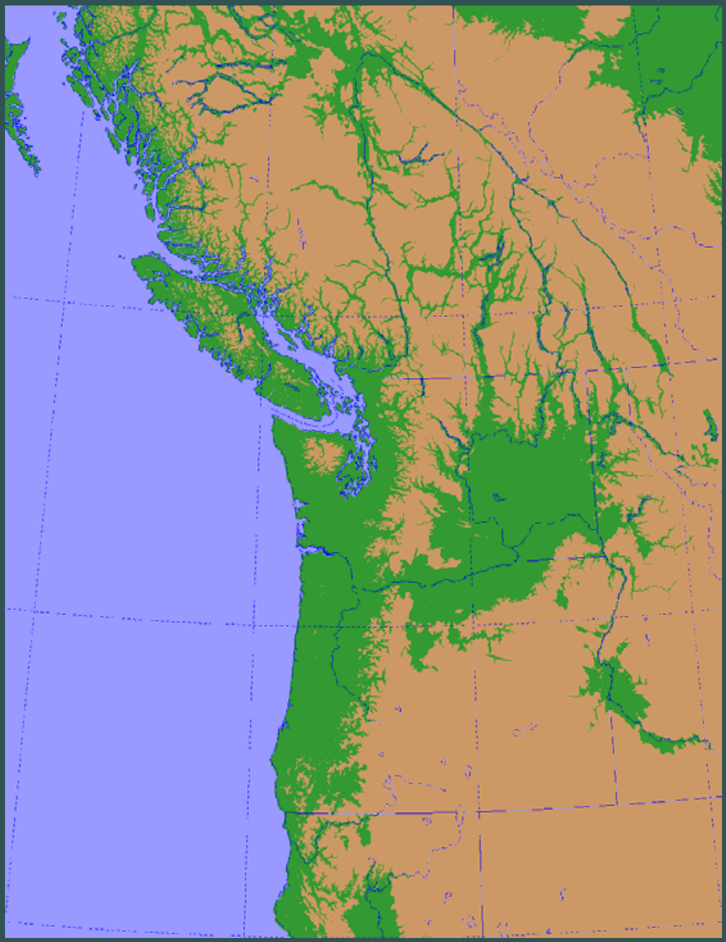
Began in mid 1990s

P source: TSP (0-45-0). Other elements added in factorial combination

Banded or placed near each tree

Glasshouse – plantations not available

Field – single tree plots, outdoor sandbeds,
multi-tree experiments

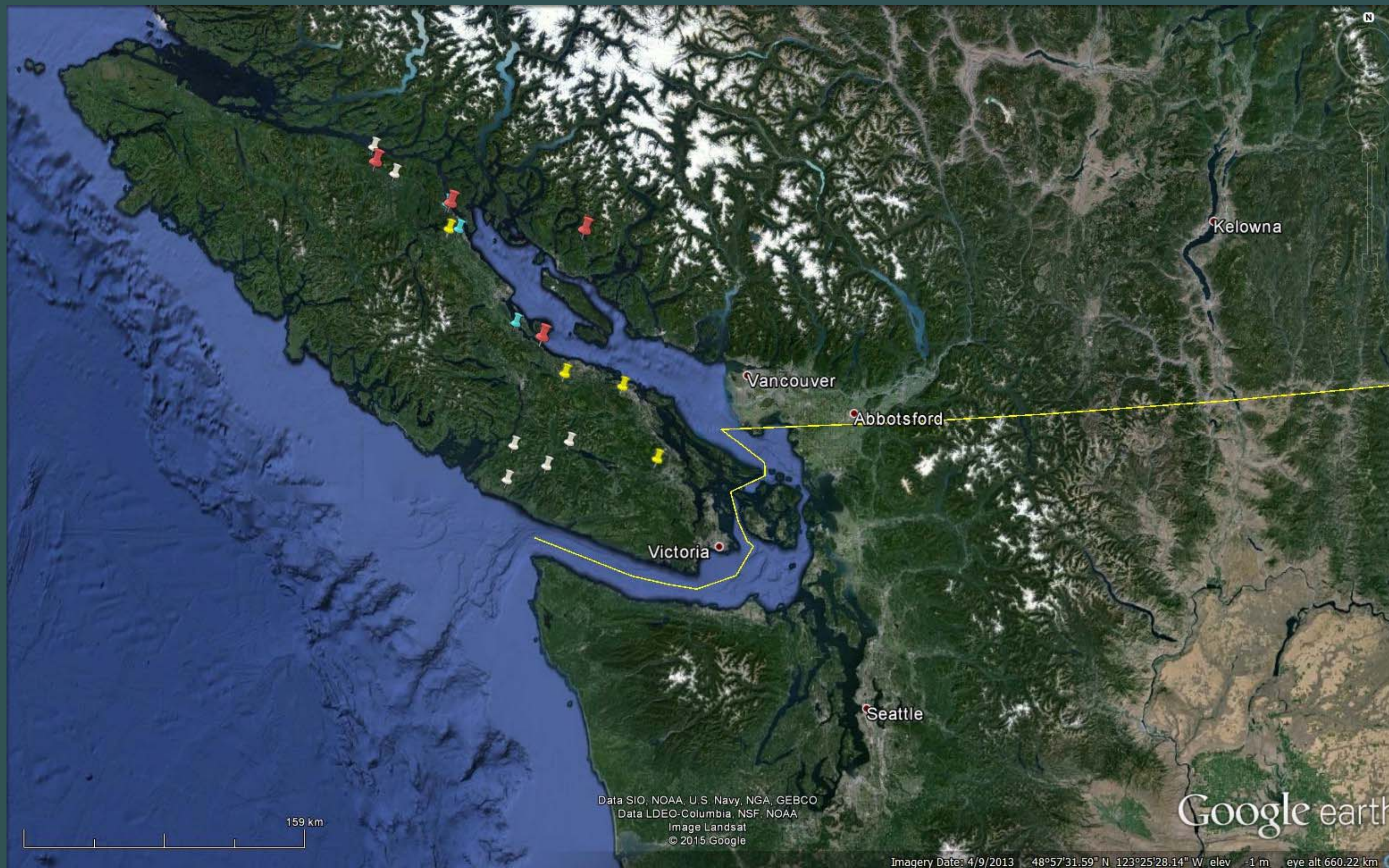


Glasshouse

Single Tree ≥ 2Yrs

Single Tree < 2Yrs

Multi Tree

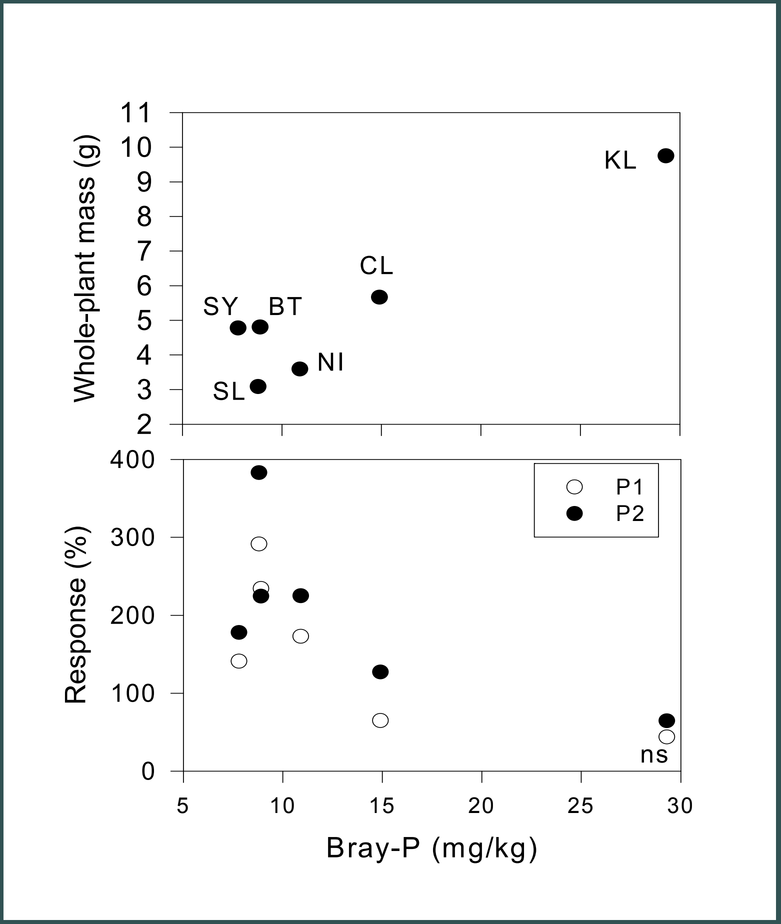


Glasshouse

Growth of unfertilized seedlings increased with soil P

Response to added P decreased with increasing soil P

Growth increased with tissue concentration of P - not other elements



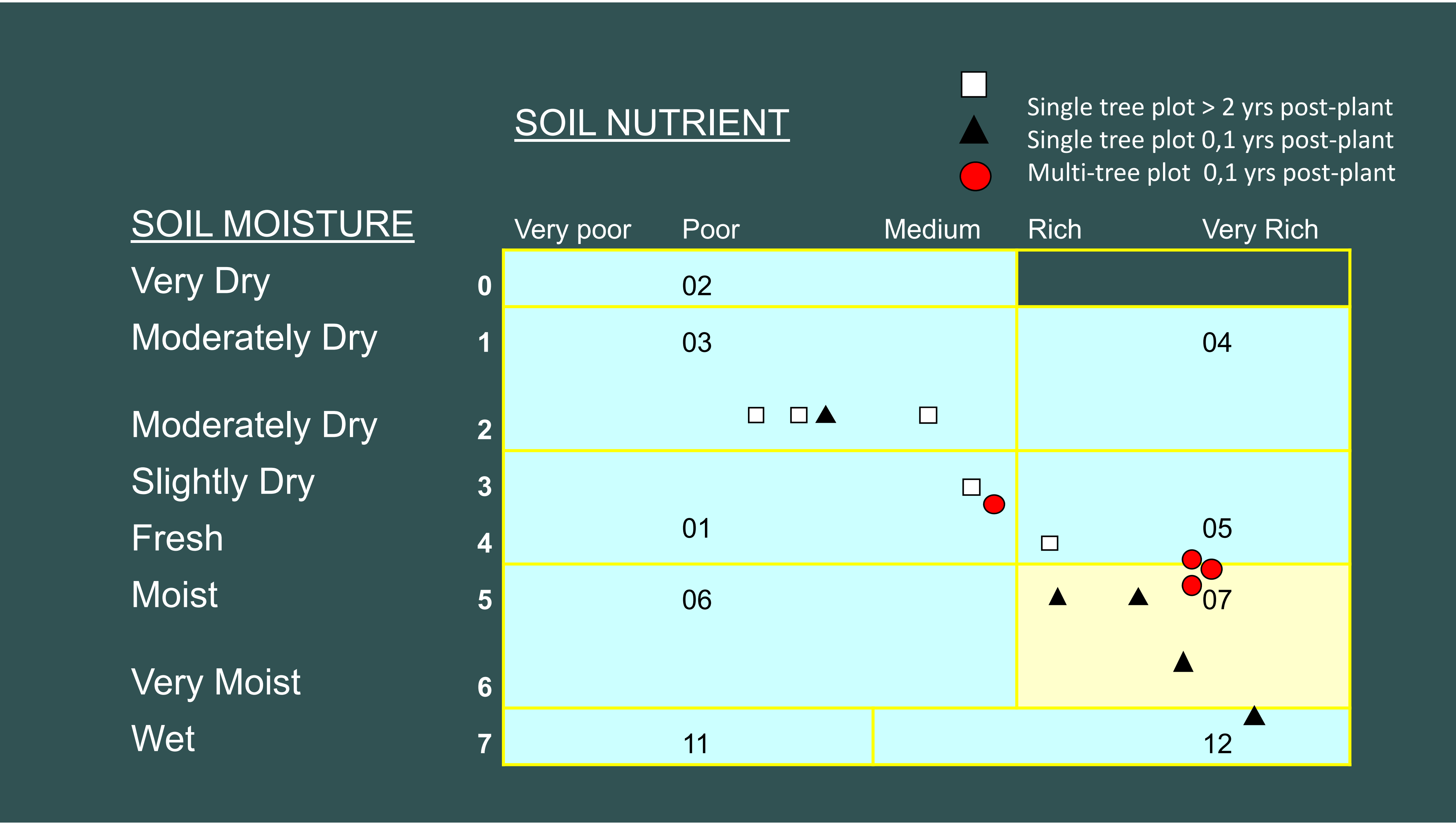
Brown and Courtin. 2003. Canadian Journal of Forest Research 33:2089

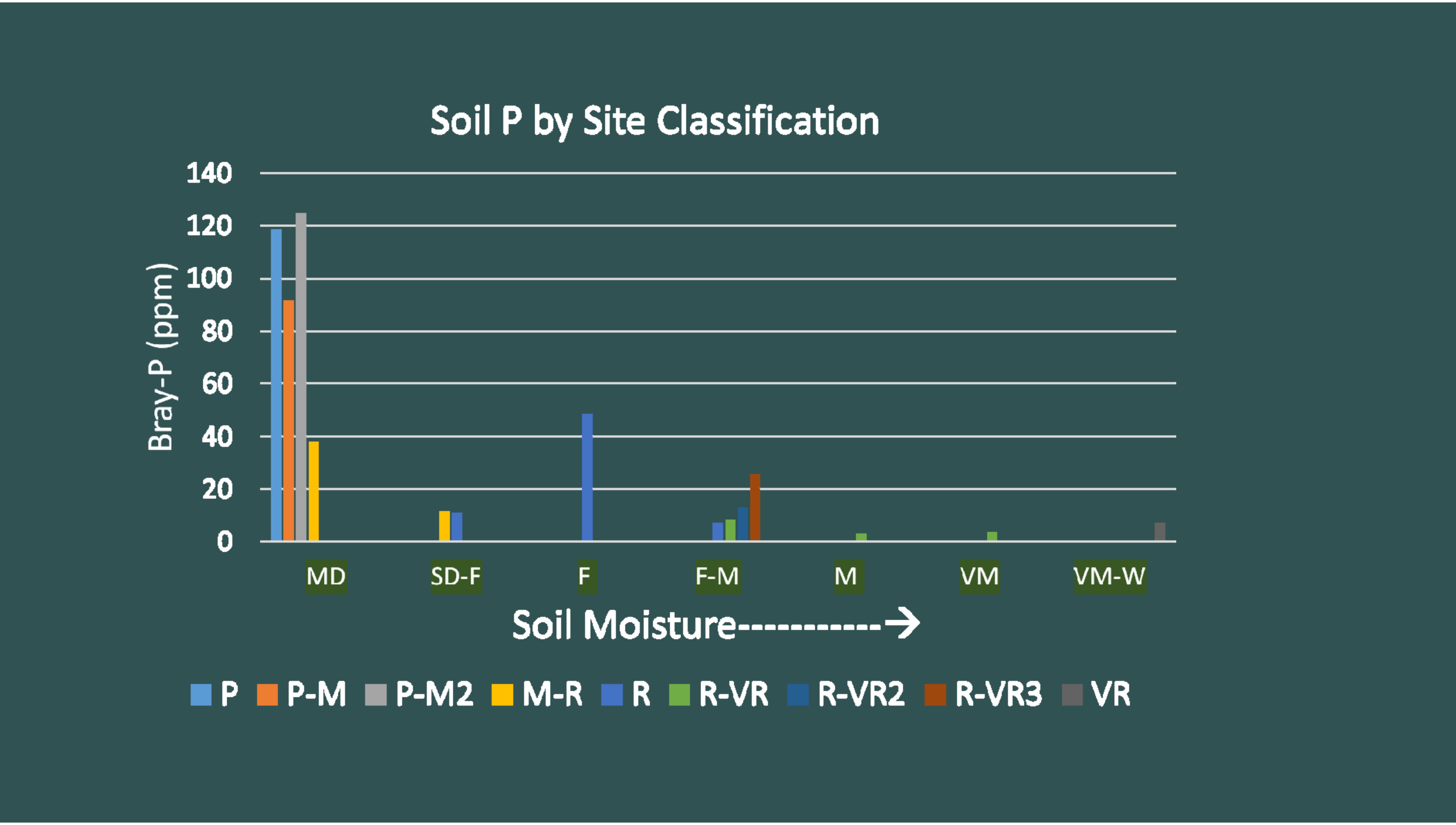
Field Experiments

- Single-tree plots
- Multi-tree plots
- Used young plantations which were available
- Framed within BC biogeoclimatic ecosystem (BEC) classification system

Biogeoclimatic ecosystem classification system (BEC)

- Hierarchical: Regional climate + late successional vegetation→ subzone
- Within subzone, physiography, soils, indicator plants are used to infer soil nutrient and moisture regimes (SNR, SMR) → site series
- Species productivity (site index) linked to site series
- Guides forest management decisions
- Linked to climate models to project future species distributions


SOIL NUTRIENT
Single tree plot > 2 yrs post-plant
Single tree plot 0,1 yrs post-plant
Multi-tree plot 0,1 yrs post-plant
SOIL MOISTURE
Very poor
Poor
Medium
Rich
Very Rich
Very Dry 0
Moderately Dry 1
Moderately Dry 2
Slightly Dry 3
Fresh 4
Moist 5
Very Moist 6
Wet 7
02
03
04
01
05
06
07
11
12



Soil P by Site Classification
Bray-P (ppm)
140
120
100
80
60
40
20
0
MD
SD-F
F
F-M
M
VM
VM-W
Soil Moisture----------->
P
P-M
P-M2
M-R
R
R-VR
R-VR2
R-VR3
VR

Single-tree plot experiments

Treatment	Lf Mass	3Y Vol	Conc ⇧	Conc ⇩
TSP -- P, Ca (0, 10, 20 gP / tree)	⇧	+ 65%	N P S Fe Mg(2) Ca(1)	K Cu Zn Mn
Blend -- K, Mg, S Fe, B, Cu, Zn, Mn	-------	+ 15%	N K S Fe B Zn Mn	Ca Cu

P seemed most limiting

Brown and Courtin. 2006. USDA Forest Service General Technical Report 669. pp 61-69
Brown and Courtin. 2007. Western Journal of Applied Forestry 22:116-123

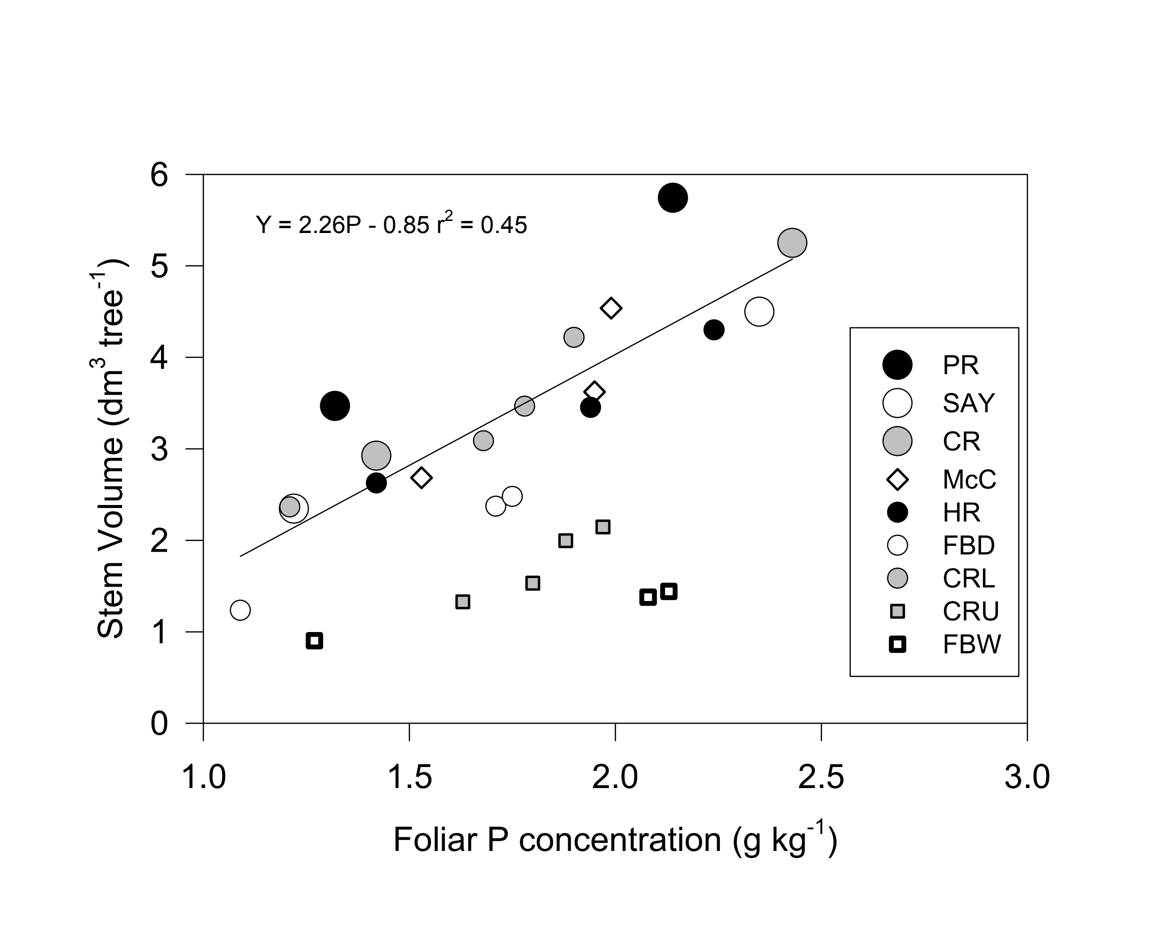
Effect of site on 3-year growth response to P

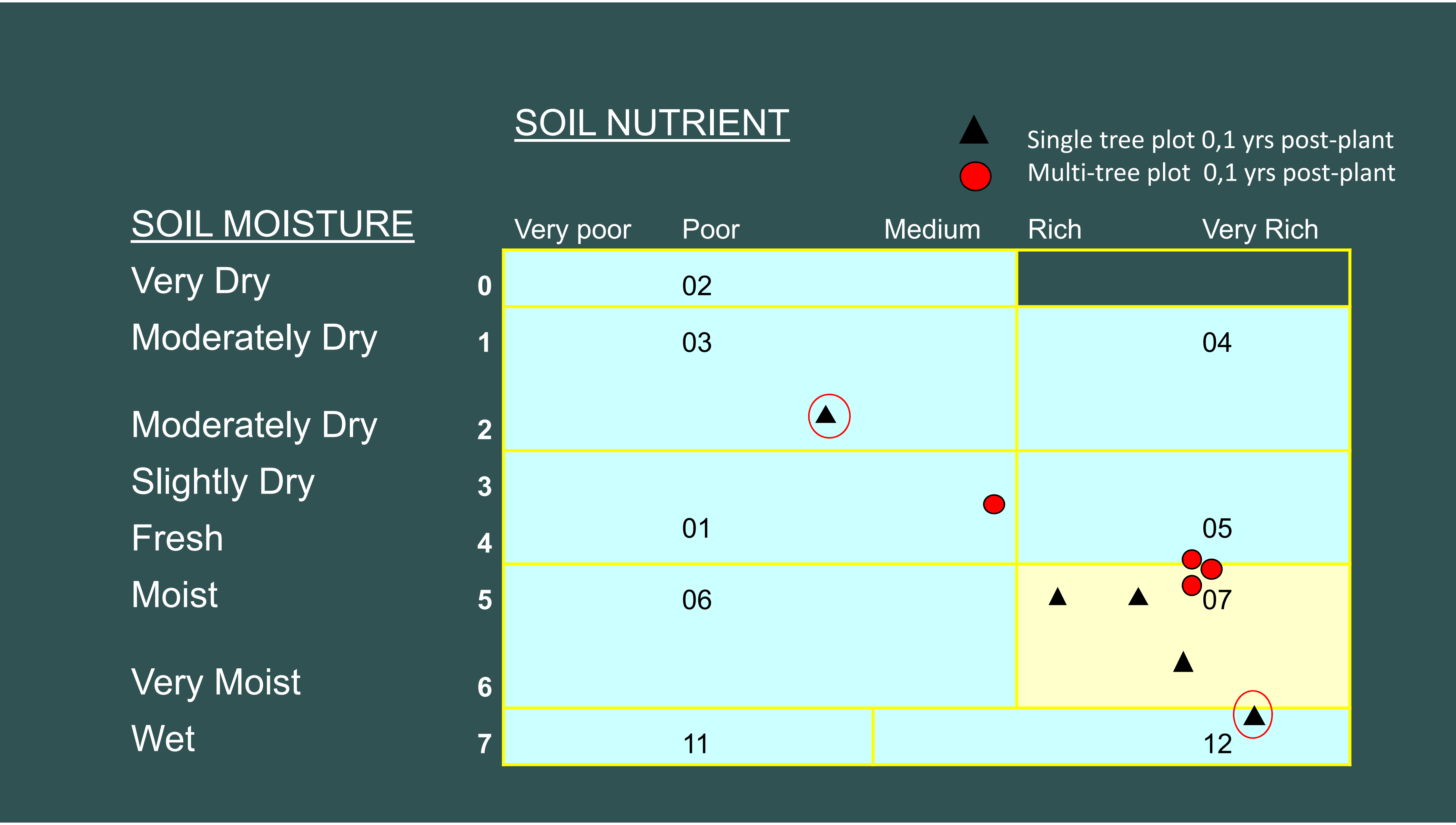
P additions increase:

- Foliar P concentration, Stem volume

Volume in comparable treatments:

- Greater in mesic; least in wet, dry





SOIL NUTRIENT
Single tree plot 0,1 yrs post-plant
Multi-tree plot 0,1 yrs post-plant
SOIL MOISTURE
Very poor
Poor
Medium
Rich
Very Rich
Very Dry
Moderately Dry
Moderately Dry
Slightly Dry
Fresh
Moist
Very Moist
Wet
0
1
2
3
4
5
6
7
02
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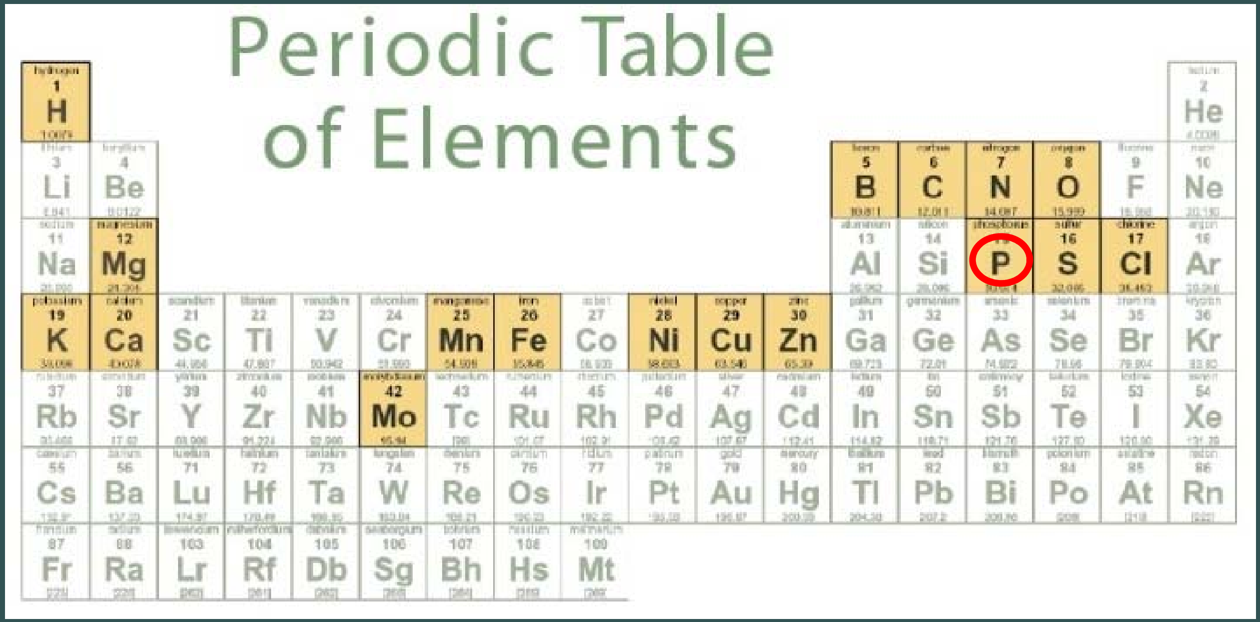
12

P seems limiting to early growth

Additions of P may increase foliar N content

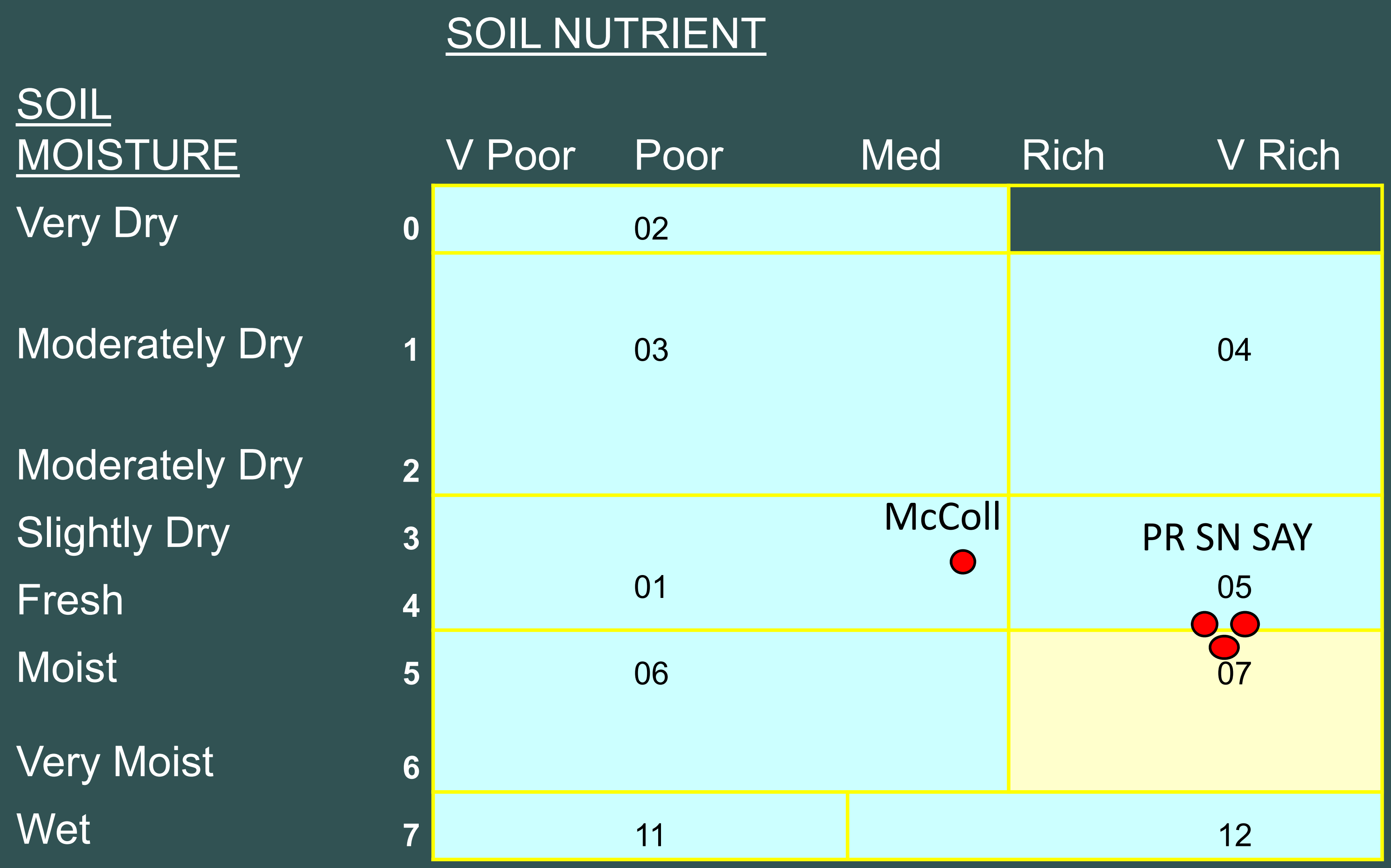
No consistent evidence for other deficiencies – but not examined in-depth



Long-term effects of P additions on growth

No evidence for growth increase if P added > 3 years after planting
(but we don't know why)

What is the long-term effect on nutrition and growth?


SOIL NUTRIENT
SOIL MOISTURE
V Poor
Poor
Med
Rich
V Rich
Very Dry 0
Moderately Dry 1
Moderately Dry 2
Slightly Dry 3
Fresh 4
Moist 5
Very Moist 6
Wet 7
02
03
04
McColl
PR SN SAY
01
05
06
07
11
12

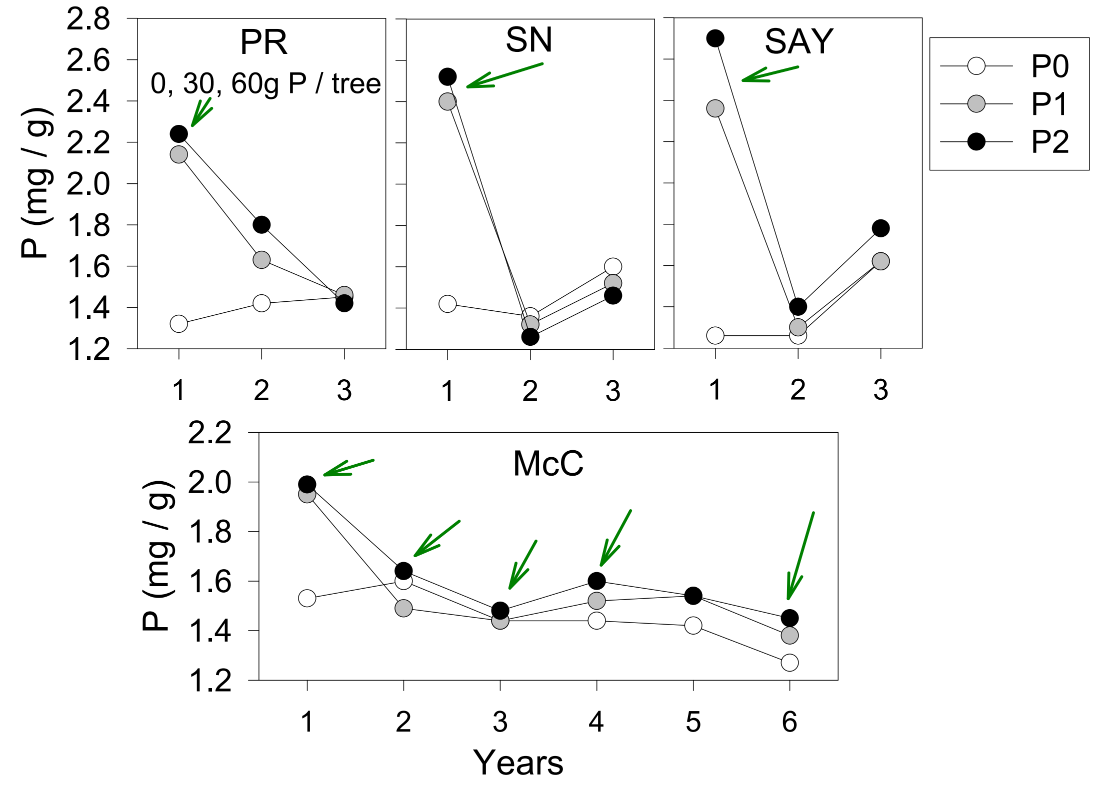
<u>All Sites:</u>

P additions within 1 year of planting increased foliar P in the year fertilized

<u>McColl (McC) Site:</u>

P additions > 2 years after planting may / may not increase foliar P

Repeated P additions increased foliar N contents 21 % through year 6



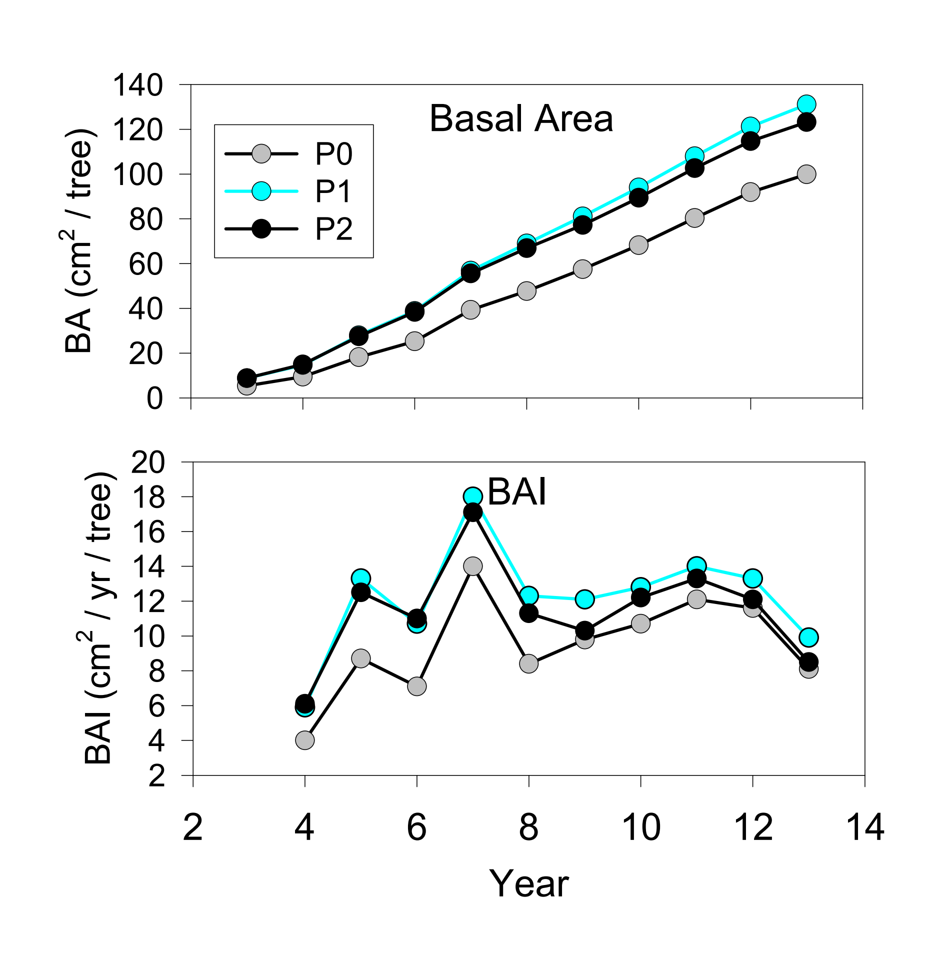
Y 1 (g P / tree)	Y 2	Y 3	Y 4	Y 6
0, 15, 30	0, 0, 15	0, 5, 10	0, 21, 33	0, 0, 196 (!!)

At driest, least fertile site (McColl):

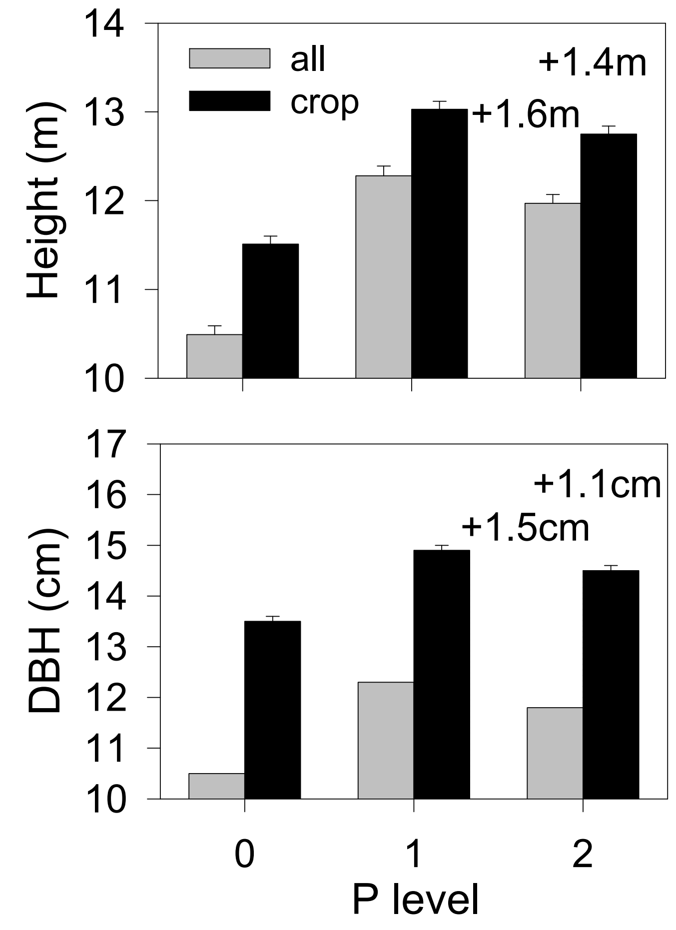
P additions increased basal area over 13 years

P additions increased BAI through 13 years

Effect of P may have been greater in some years



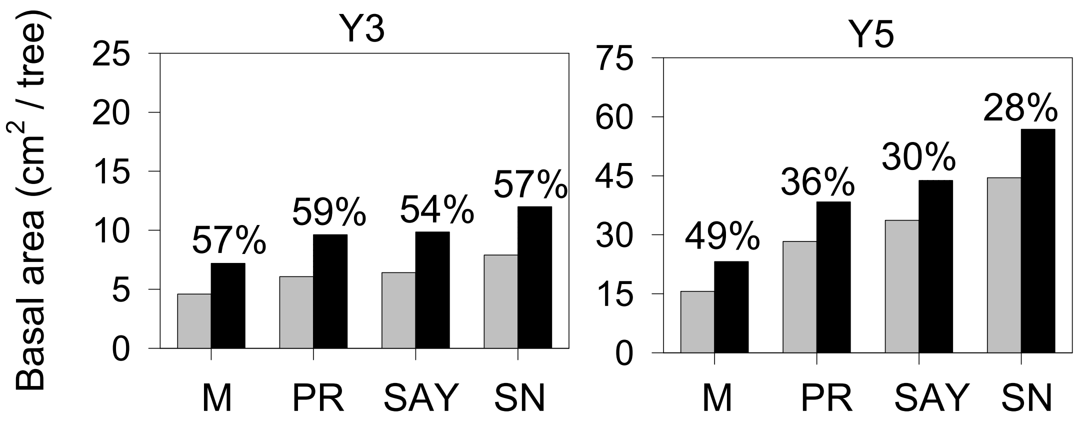
Effects of P additions on “crop” trees are less than for all trees



Over the long-term, effects of P additions vary with site and time

Absolute effect greater in mesic sites through 3, possibly 5 years

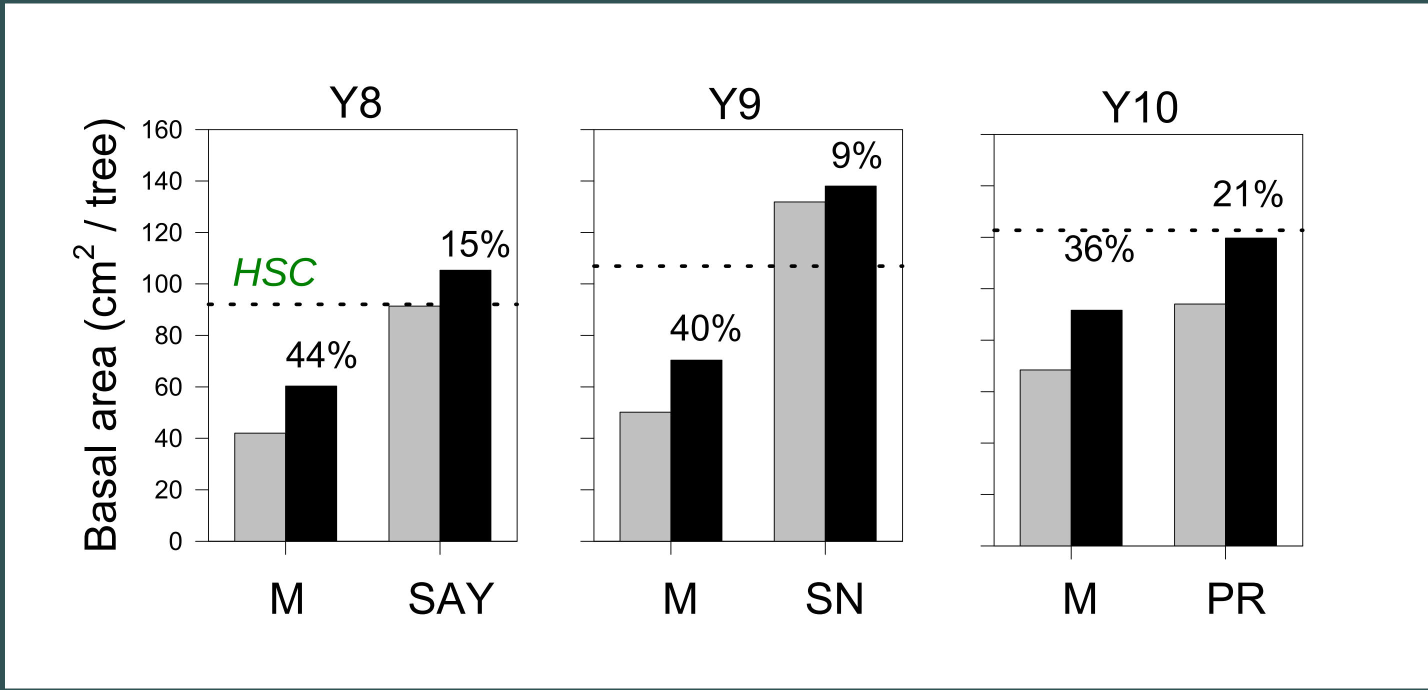
May accelerate free–to-grow status and canopy closure



Effects of P additions years 8-10 similar or less in mesic sites (SAY, SN, PR)

Are the differences due to:

Site?
Stand growth?
Treatment Differences?



HSC means adapted from Bluhm and Hibbs 2006. USDA Forest Service General Technical Report 669

Summary – Red Alder Nutrition

P deficiencies may limit early growth of red alder in south coastal BC

No evidence for deficiencies of other elements, but…

P deficiencies may be inferable from available-P data + site quality guidelines

- May improve site selection
- May suggest if fertilization at planting is beneficial

If fertilizing, add P within 1 year of planting – effects have persisted for 10+ years on some sites

If using TSP, place it, don't broadcast- 20gP per tree may be enough

What is the best way to ensure sufficient nutrients?

Conserve topsoil

P-fertilizers have significant environmental impacts – so use wisely

Alternatives:

Alder-Paks – similar 1-year effects as P additions , but no long-term data

Organic wastes ?

What about Mycorrhizae ??????

Thanks !!

People:
Paul Courtin, Neil Hughes, Rod Negrave, Ronan O’Donovan,
Numerous co-op students

Those who have laid groundwork and provided the inspiration
Those who are interested in alder silviculture

Funders:
BC Ministry of Forests, Forest Renewal BC, BC Forest Investment Account
Northwest Hardwoods, PRT, Western Forest Products


CHERRYVILLE
UNINCORPORATED
THIS IS A
D.A.R.E.
TO RESIST DRUGS
AND VIOLENCE
COMMUNITY

Why Bitter Cherry?

“Shrubs or small trees, 2-15m tall” (Pojar and Mackinnon 1994 Plants of the PNW Coast)

“Extreme skinniness, weak, short-lived, mediocre wood value” (Jacobson 2006 Trees of Seattle)

“…Woodland Beauty…, when…their ultimate size, but not yet toppled, …make(s) up for their lack of strength or utility” (Jacobson, 2008 Wild Plants of Greater Seattle)

Why cherry?

Locally abundant on S, E Vancouver Island after clearcutting

Company concerns about effect of cherry regeneration on Douglas-fir plantations
→ Cost of brushing

Does it have potential as a source of wood?

Climate envelope models suggest
increasing abundance in future

We knew very little at the start!

Components of study:

Does density of cherry regen affect planted Douglas-fir?

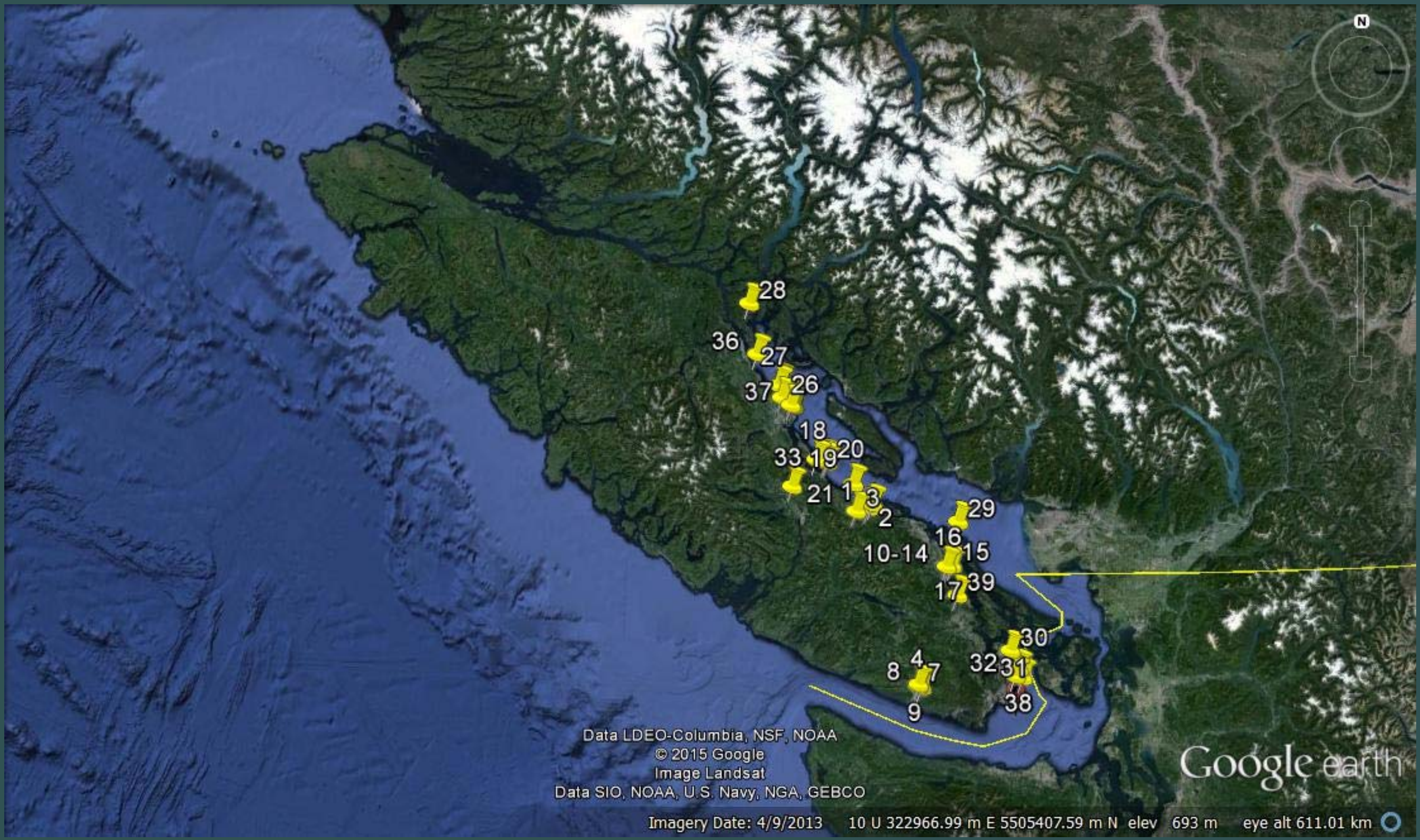
How big and old does cherry get? How does growth vary with site?

How does cherry regenerate?

What are potential problems in log and wood quality?

Cherry sample sites

~ 200 trees in 39 locations



Cherry sample trees by Site Series, Soil Moisture, and Soil Nutrient Regime

Site Series	SMR	SNR
01	SD – F	VP - M
05	SD - F	R – VR
07	M - VM	R – VR

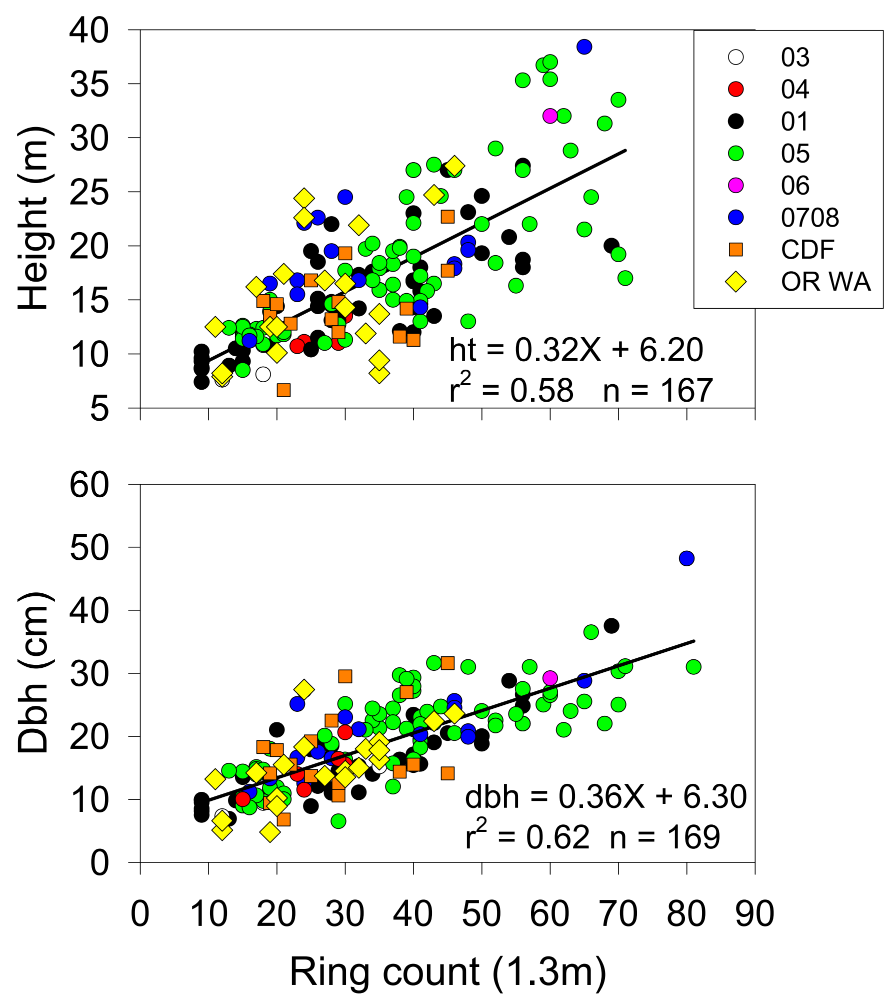
- Most sampled trees were in Slightly dry – Moist and Medium – Very Rich sites
- CWHxm , CDFmm subzones

	SOIL NUTRIENT REGIME				
MOISTURE	VeryPoor	Poor	Medium	Rich	VeryRich
Very_Dry					
Mod_Dry	xx	x	x xxxxx	xxxxxx	
		xx	xxxxxx	xxxxxxxxxxxxxxx	
SL_Dry		xx	x xxxxx x	xx x	
Fresh		xxx	xxx xxxxxxxxxxxxxxx xxx xxxxxxxx	xxxxxxxxxxxxxxx xxxxxxxxxxxxxxx xxxxxxx xx	xx xxxxxxxx
Moist	x		xxxx x	xxxxxxxxx xxxx	xxxx xxxxxxxx
VeryMoist			x x	xxxxx	
Wet					

Height, Diameter, Age of Bitter Cherry

- Site Series in the CWHxm
- CWHxm vs CDF
- W. Oregon, W. WA (FIA data)

- Maximum age ca. 80 years (1.3m)
- Maximum Height ca. 40m
- Maximum DBH ca. 35cm

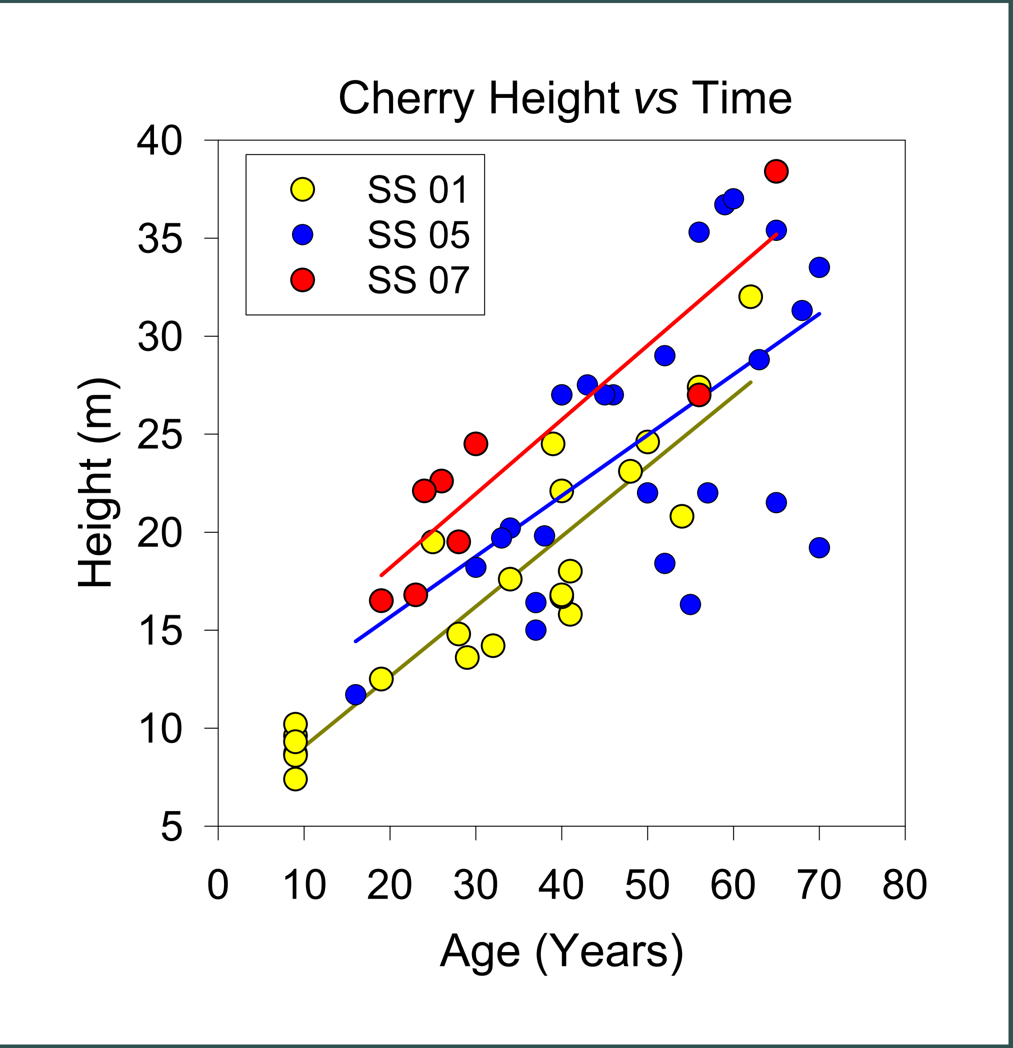


Does height growth rate increase with site quality?

Possibly!!!

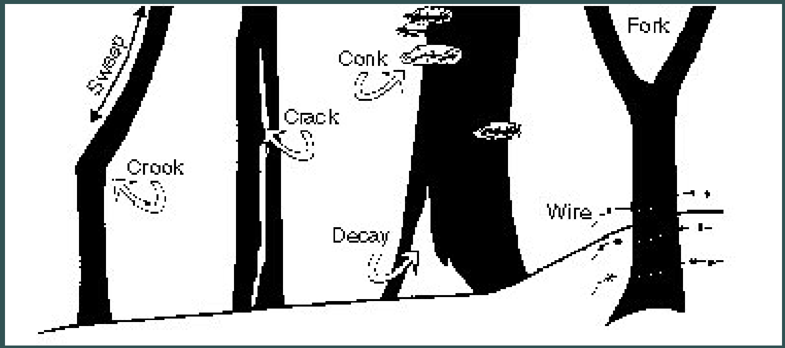
Would be useful to have:

1. growth curves for individual trees
2. Age to breast-height (1.3m)



Wood / Log quality

- Sweep, Forks, Lean on standing trees

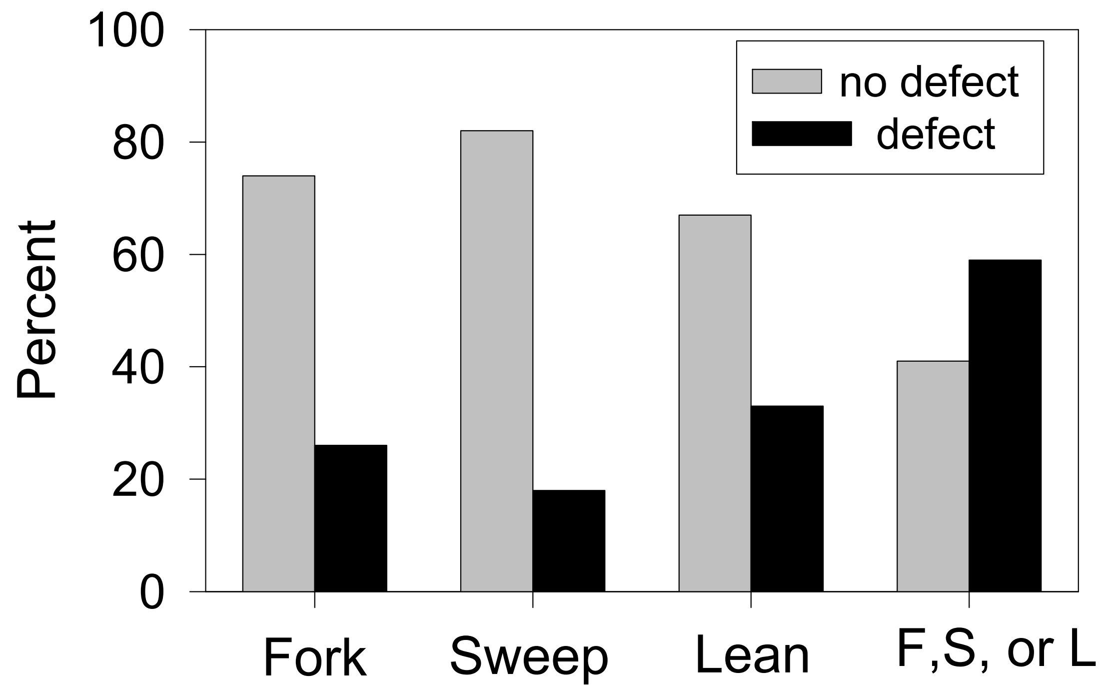


- Questionnaires to woodworkers, sawmill operators

- Sawn cherry to Camosun College Fine Furniture Program

Percent of cherry with defect in first 3.2m log

- 74% without fork in first log
- 82% with <10cm sweep
- 67% with < 10° lean
- 41% lacking F, S, or L

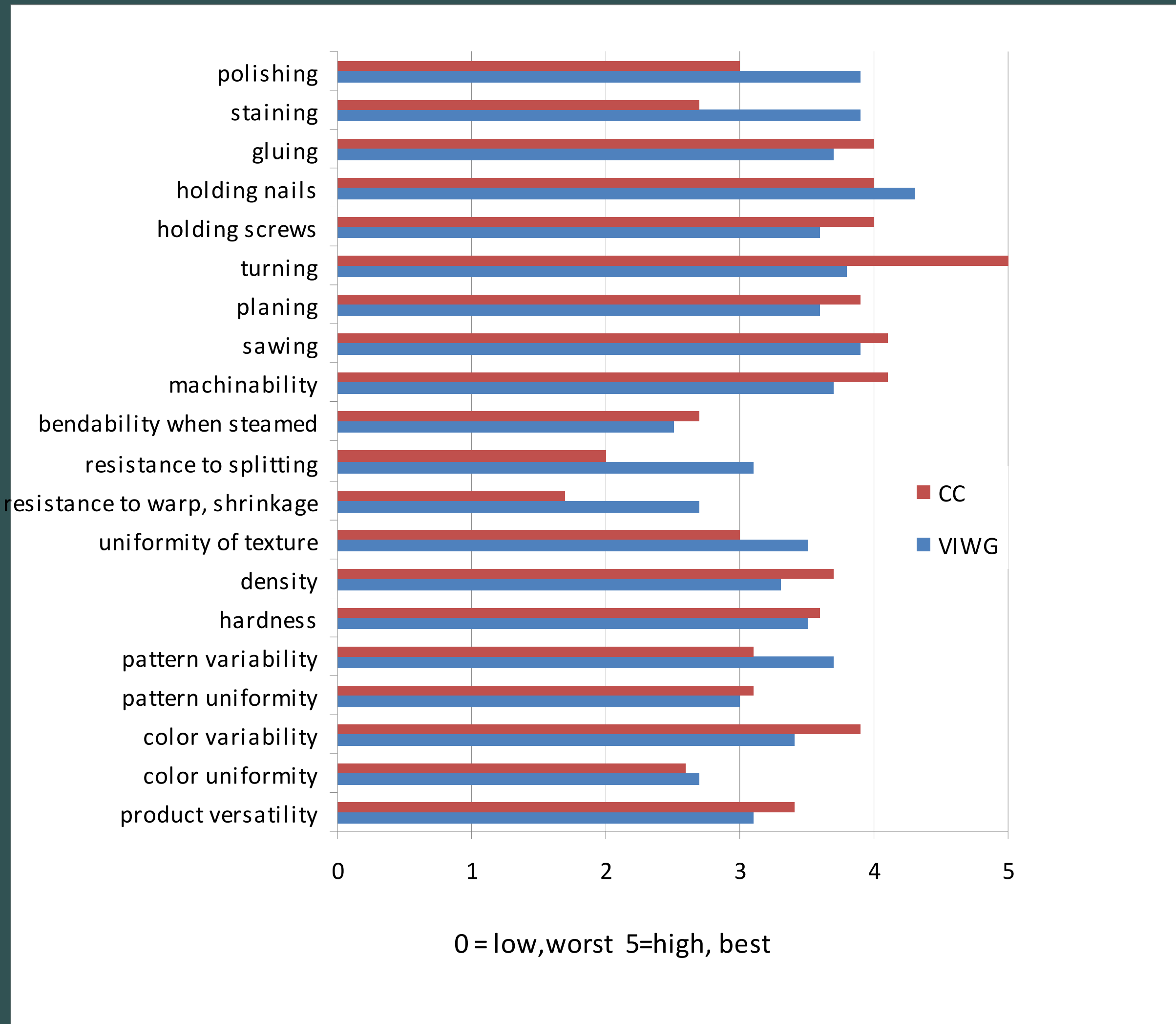


Questionnaire

Asked woodworkers to compare bitter cherry w/ other native hardwoods

Better for turning, gluing, machining, finishing

Worse for warping, shrinkage, tendency to split



Camosun College Fine Furniture Program

Weaver Armstrong cherry

Oliver Scott cherry, walnut

Real Guay cherry

Nick Donaldson cherry, alder

Adam Henry cherry, alder

Courtney Campbell cherry, alder, walnut

Kathy How cherry, alder

Bitter cherry size and age

Cherry maximum size and age is greater than generally reported

Early growth rates are probably less than for red alder

Stem form can be a problem, but some large trees had long straight clear stems!

Bitter cherry wood

Workable and nice appearance, but considerable waste depending on stem quality

Limited and unpredictable supply