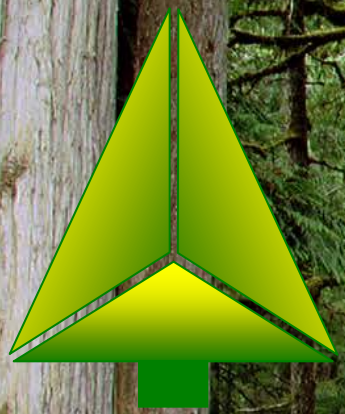
Nutrition management of cedar and hemlock plantations in coastal British Columbia



The Salal Cedar Hemlock Integrated Research Program

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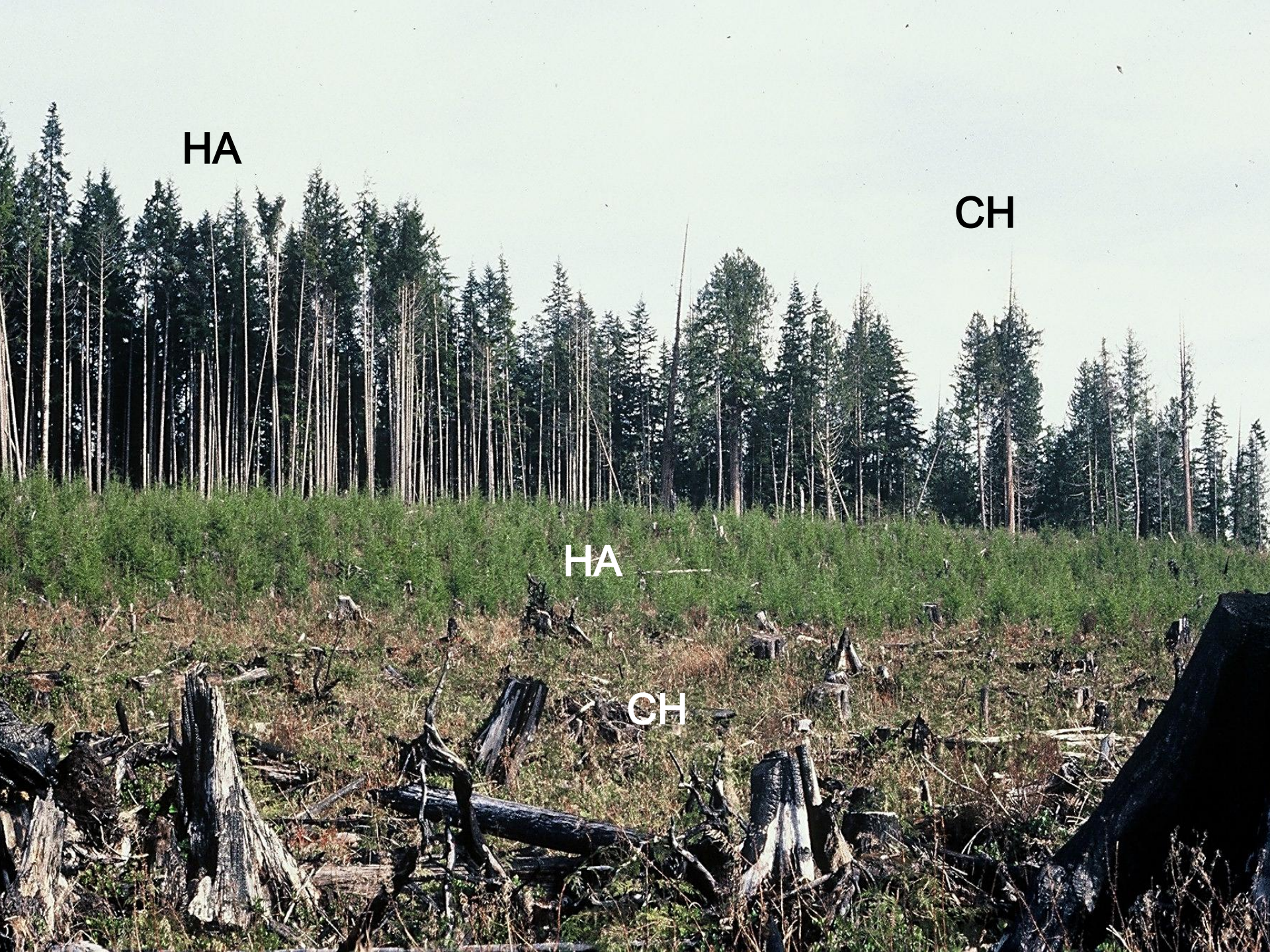
Dr John Barker

Dr Gordon Weetman

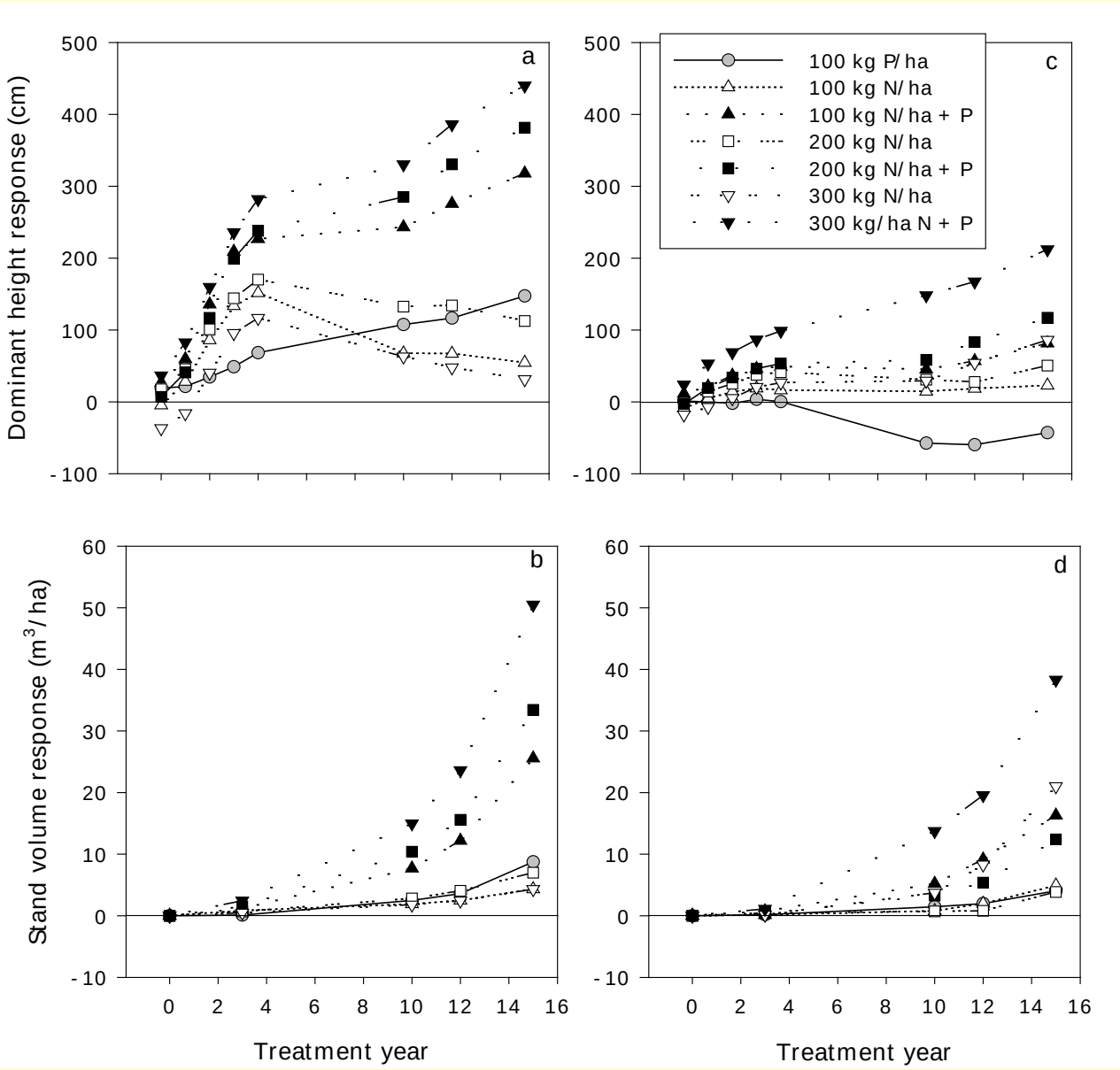

Vancouver Island
Port Hardy
Campbell River
Powell River
Courtenay
Strathcona Provincial Park
Port Alberni
Parksville
Nanaimo
Ladysmith
Victoria
Whistler
Stein Valley Nlaka'pamux Heritage Park
Garibaldi Provincial Park
West Vancouver
Vancouver
Surrey
White Rock
Abbotsford
Bellingham
North Cascades National Park Visitor Center
Everett
Lynnwood
Olympic National Park
Seattle
Bellevue
Kent
Tacoma
Lakewood
Aberdeen
Olympia
Centralia
Mt Rainier National Park
Yakima
Wenatchee
Washington
Kamloops
Merritt
Hope
Chilliwack
Princeton
Vernon
Kelowna
Summerland
Penticton
Osoyoos
Richland
Kennewick
Astoria
St Helens
Vancouver
Portland


Problem:
The Problem
Poor conifer regeneration on cutovers of old-growth cedar hemlock (CH) forests


HA
CH
HA
CH


REHABILITATION PROJECT
FERTILIZER
SCREENING
TRIALS
1984

N vs N+P


hemlock
cedar
a
b
c
d
Dominant height response (cm)
Stand volume response (m3/ha)
Treatment year
Treatment year
100 kg P/ha
100 kg N/ha
100 kg N/ha + P
200 kg N/ha
200 kg N/ha + P
300 kg N/ha
300 kg/ha N + P

N+P co-limitation - salal

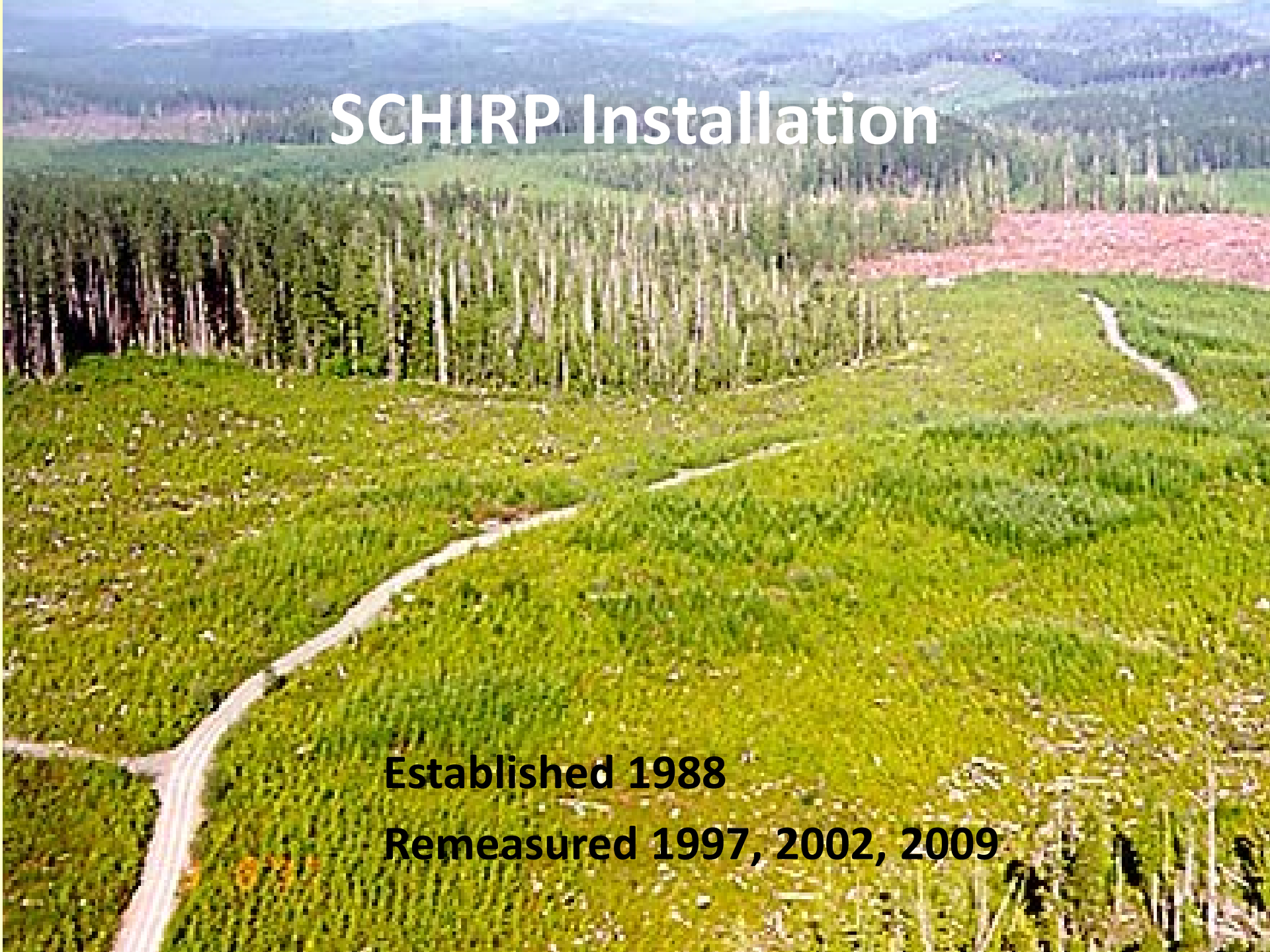
Management Strategy for CH Sites

Management Strategy for CH Sites

- Site preparation to control salal,
- prompt planting of cedar (and hemlock)
- at densities ≥1500 st/ha
- fertilize at planting and every 5-10 years until crown closure

Blevins and van Niejenhius 2003 Stand Establishment Decision Aid for nutrient-deficient, salal-dominated sites.
http://www.forrex.org/stand-establishment-decision-aids-sedas

SCHIRP Installation



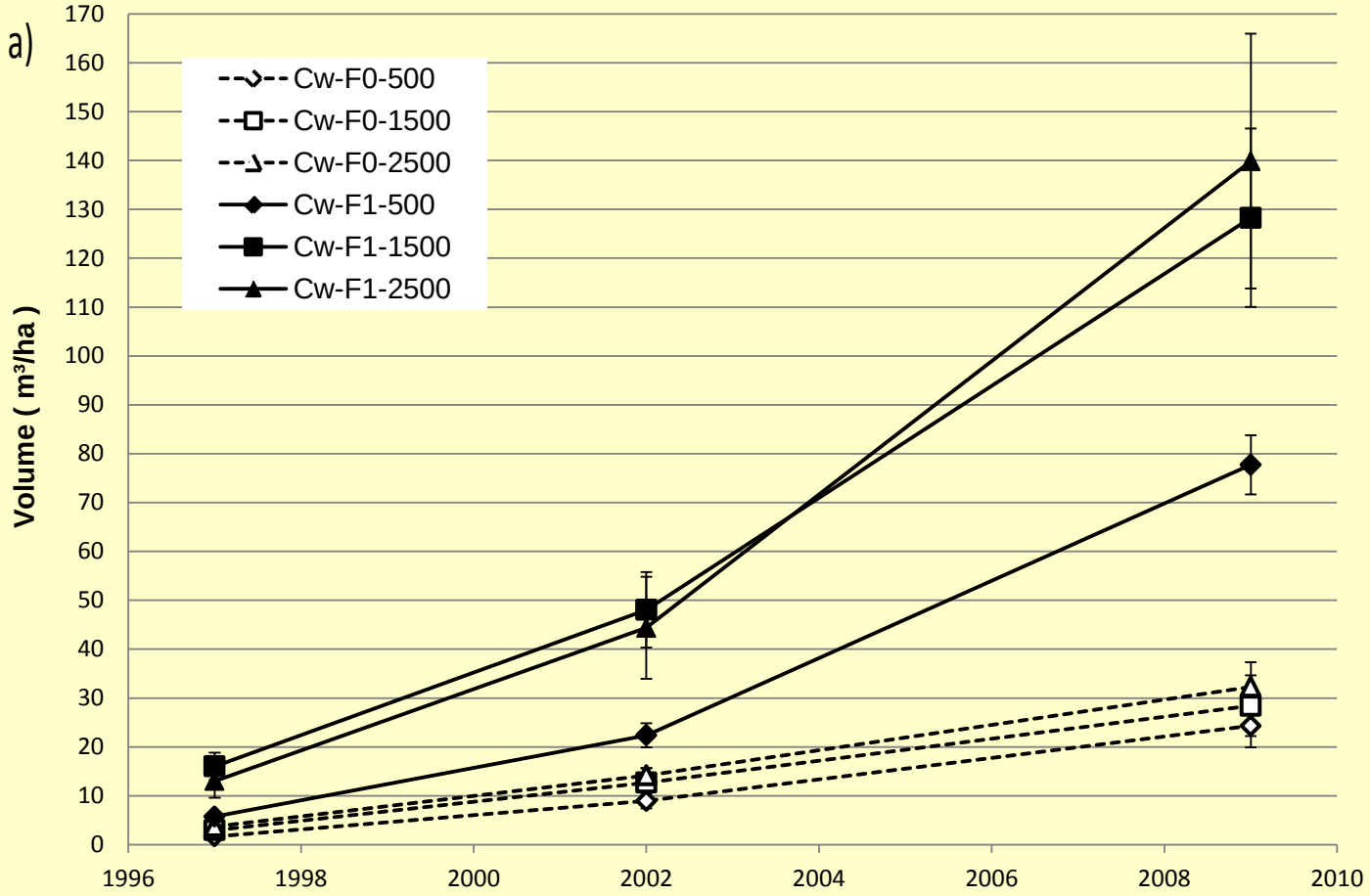
Established 1988

Remeasured 1997, 2002, 2009

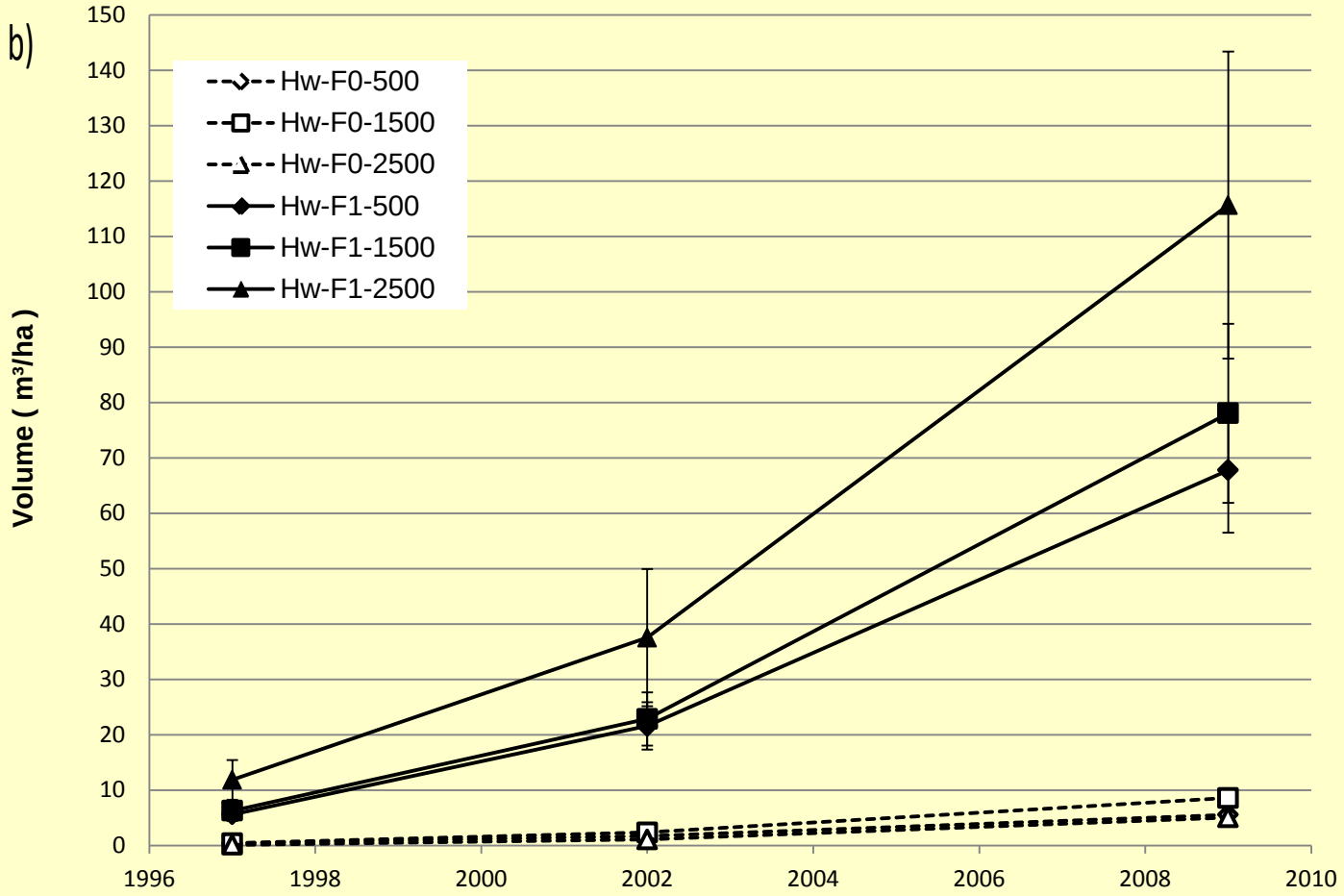
SCHIRP Installation

- **96 plots - 48 CH and 48 HA**
- **8 blocks (4 CH and 4 HA)**
- **2 species (western hemlock and western red cedar)**
- **3 densities (500, 1500, 2500 stems/ha)**
- **Fertilized at time of planting (**17-10-10, slow release**)**
- **Broadcast-fertilized in 1993** (225 kg N and 75 kg P /ha)
- **Re-fertilized in 2004 - broadcast (**225 kg N /ha**)**

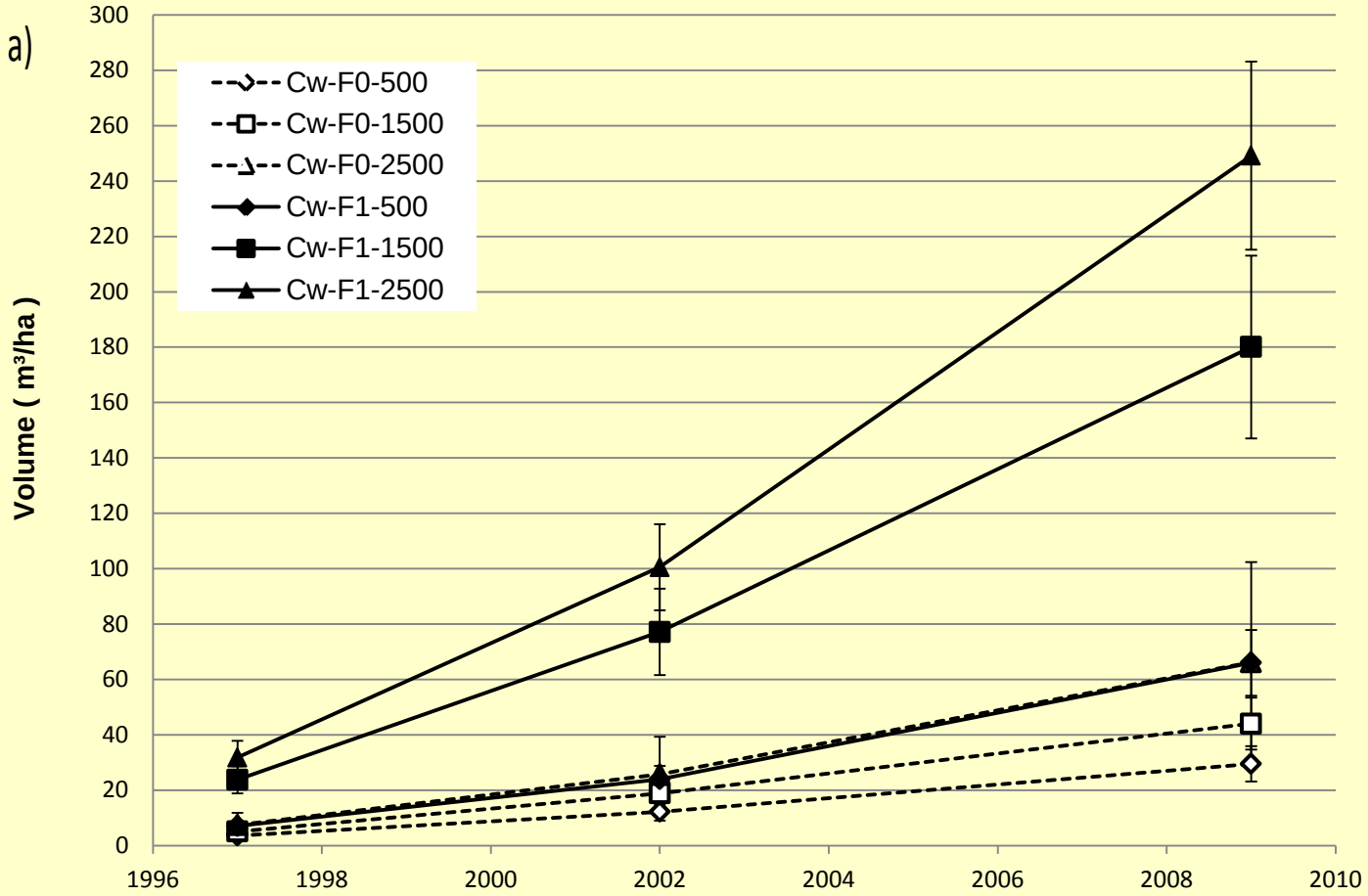
Volume response - CH sites - cedar



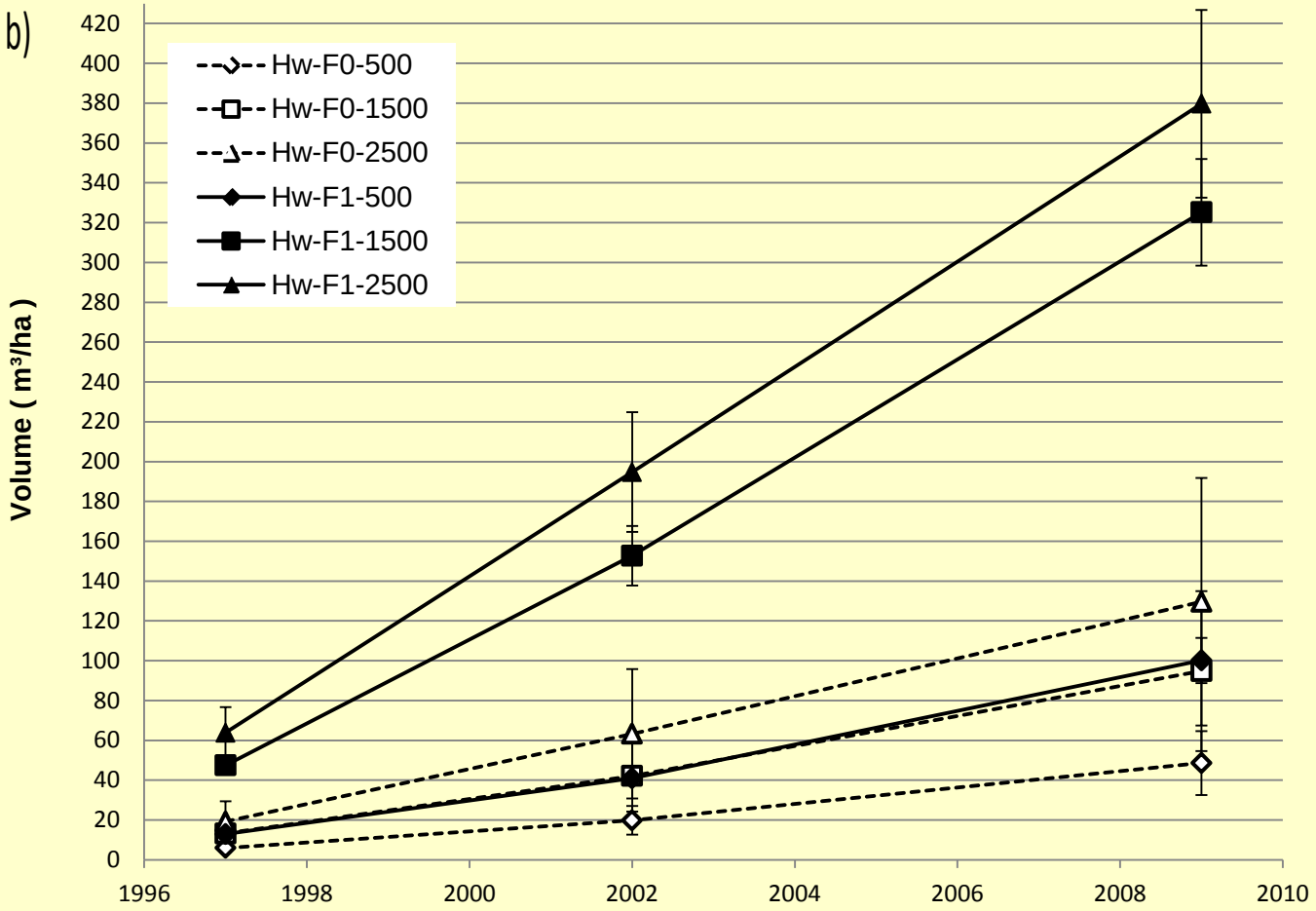
Volume response - CH sites - hemlock



Volume response - HA sites - cedar



Volume response - HA sites - hemlock



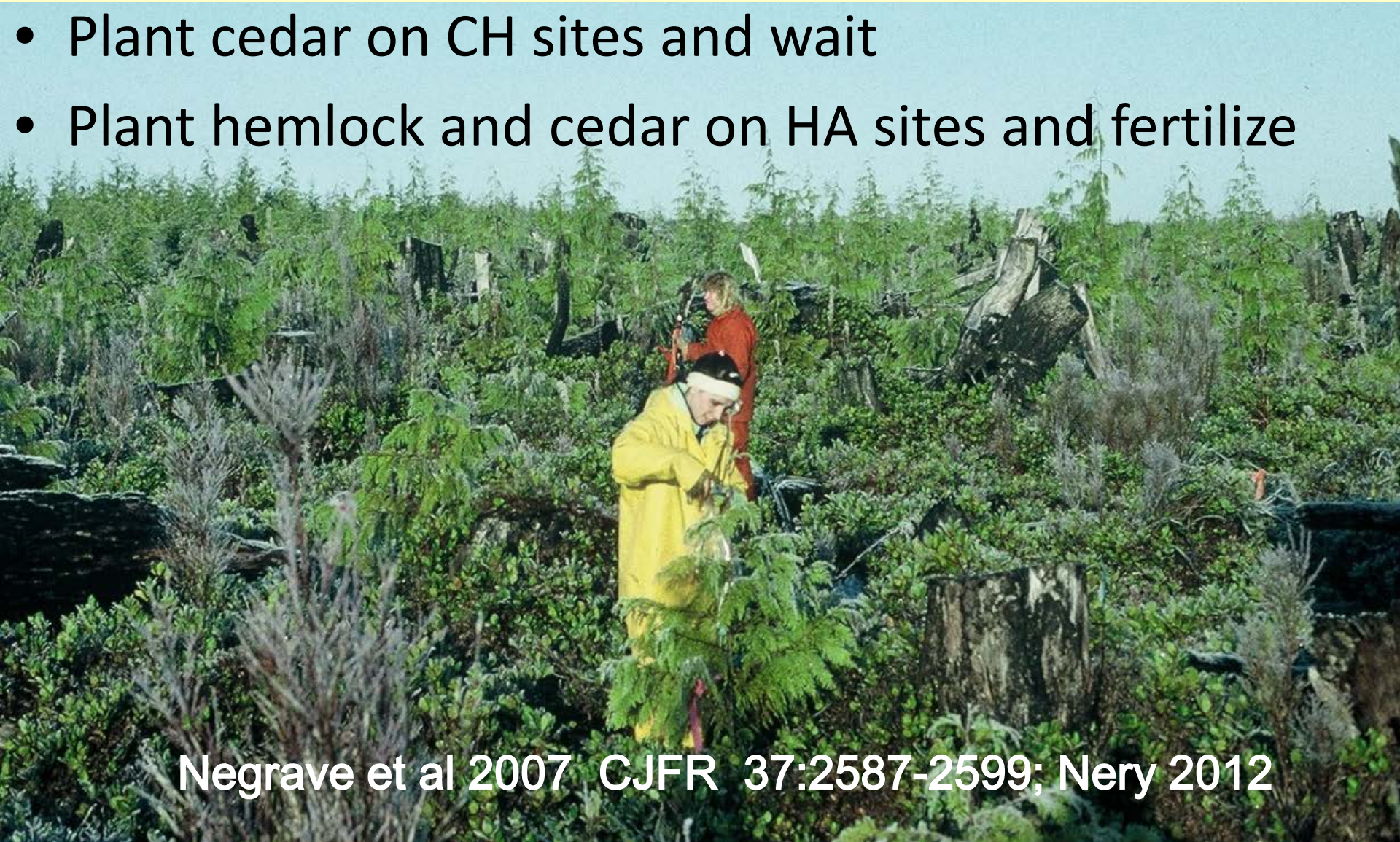
Responses on CH and HA sites

Extra volume achieved through fertilization after 21 years

	Cedar	Hemlock
CH	100 m^3	100 m^3
HA	200 m^3	270 m^3

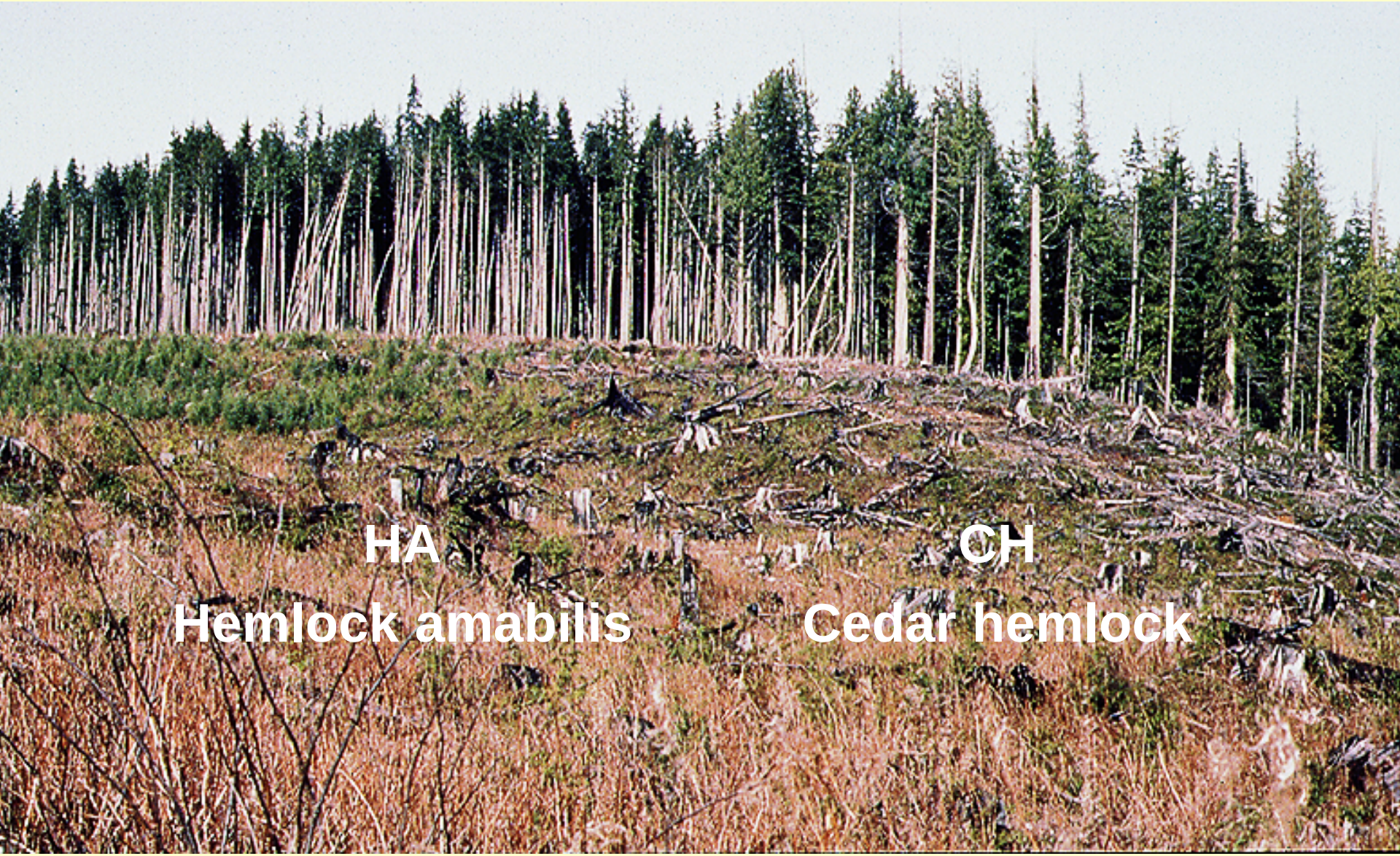
Management Recommendations

- Plant cedar on CH sites and wait
- Plant hemlock and cedar on HA sites and fertilize



Negrave et al 2007 CJFR 37:2587-2599; Nery 2012

Causes of poor nutrient supply on CH sites



Causes of poor nutrient supply on CH sites

Salal ?

Causes of poor nutrient supply on CH sites

Lack of windthrow?

No effect of mixing soil and humus on N mineralization

Little growth response to scarification

Causes of poor nutrient supply on CH sites

Succession (HA to CH) ?

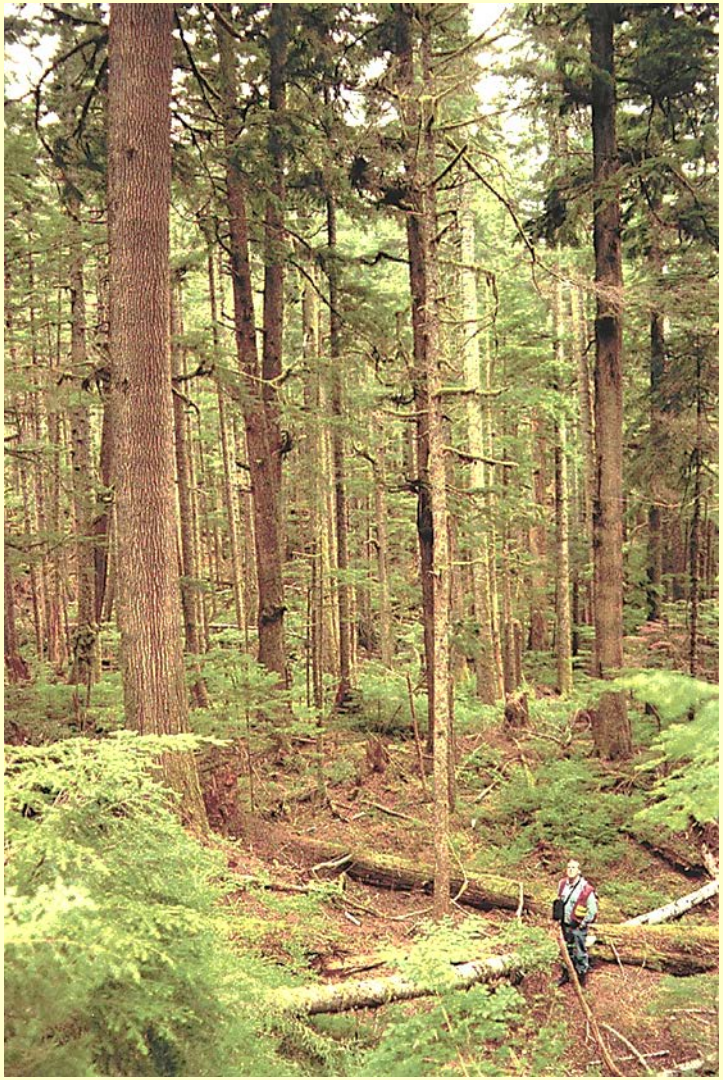
Progressive immobilization of N

in absence of disturbance?

old-growth HA forests

no intermediate forests

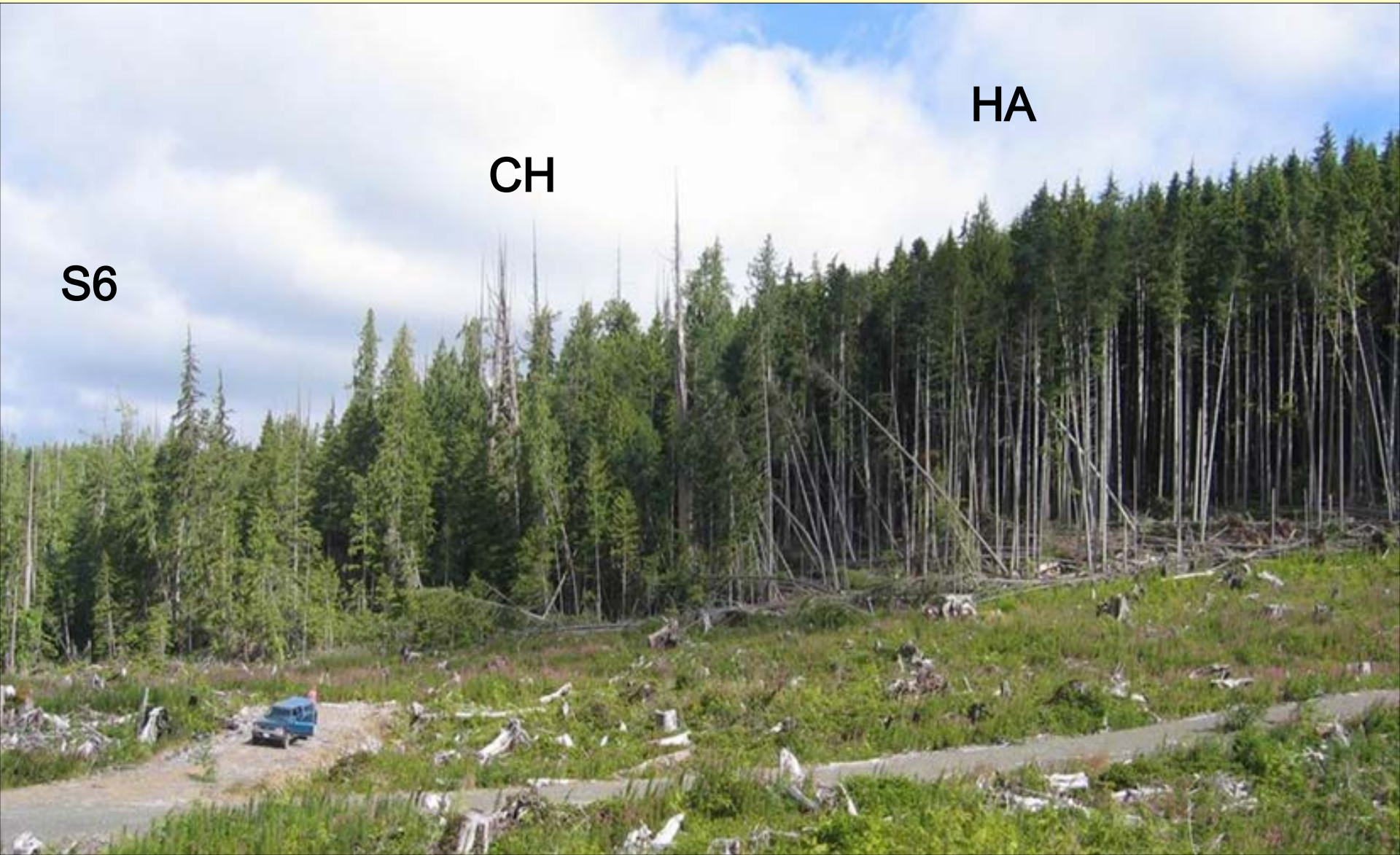
little cedar ingress into HA forests

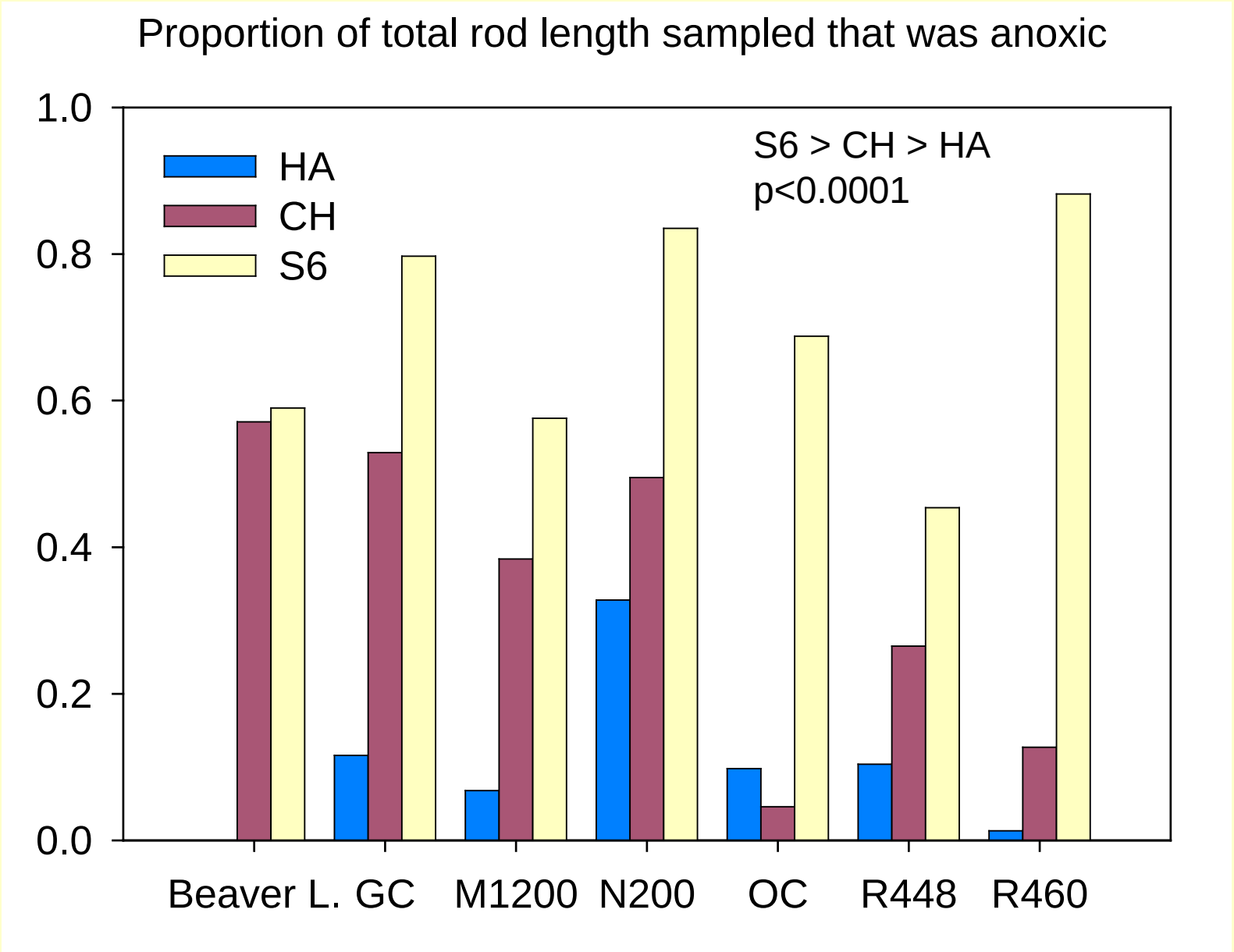


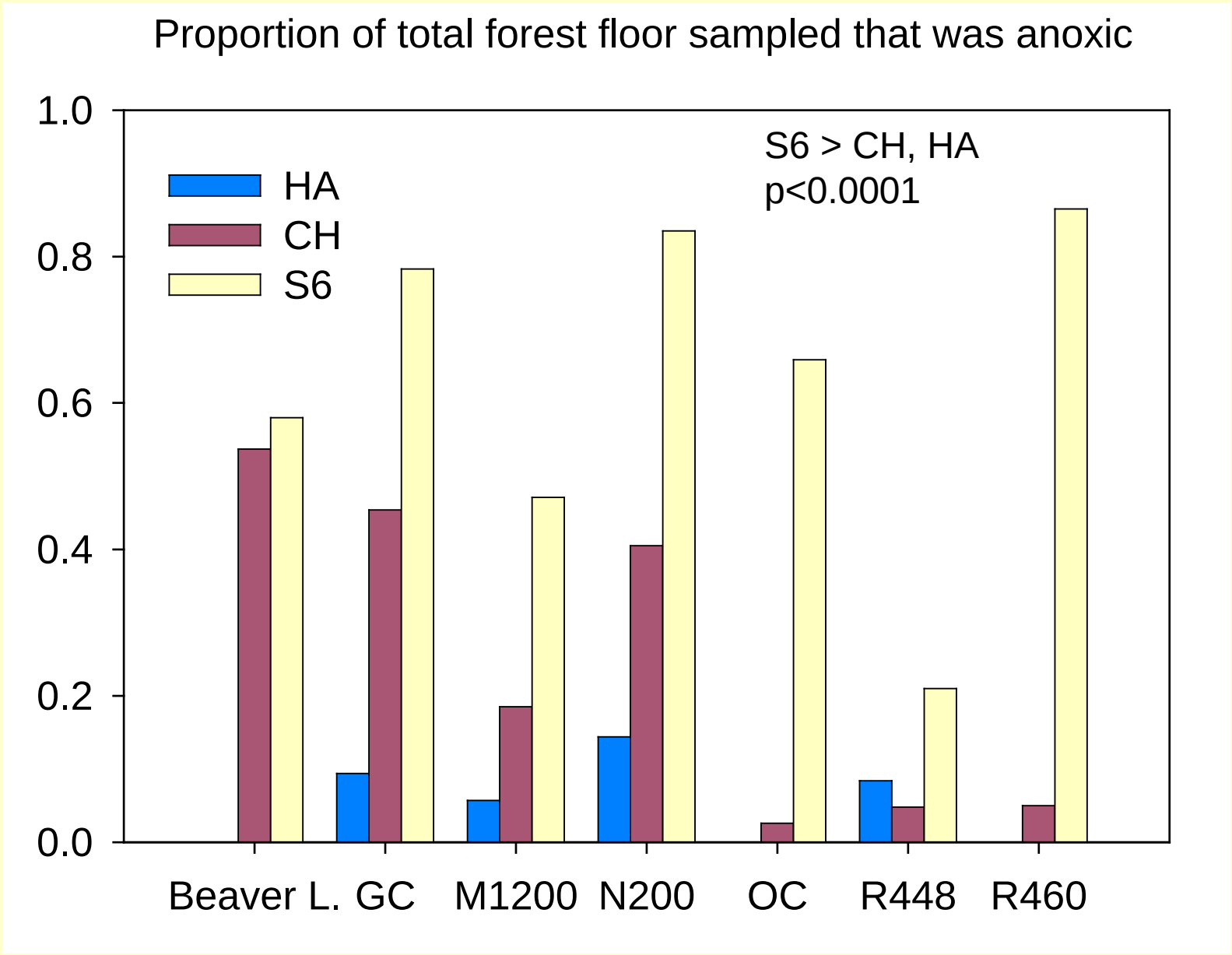
Causes of poor nutrient supply on CH sites

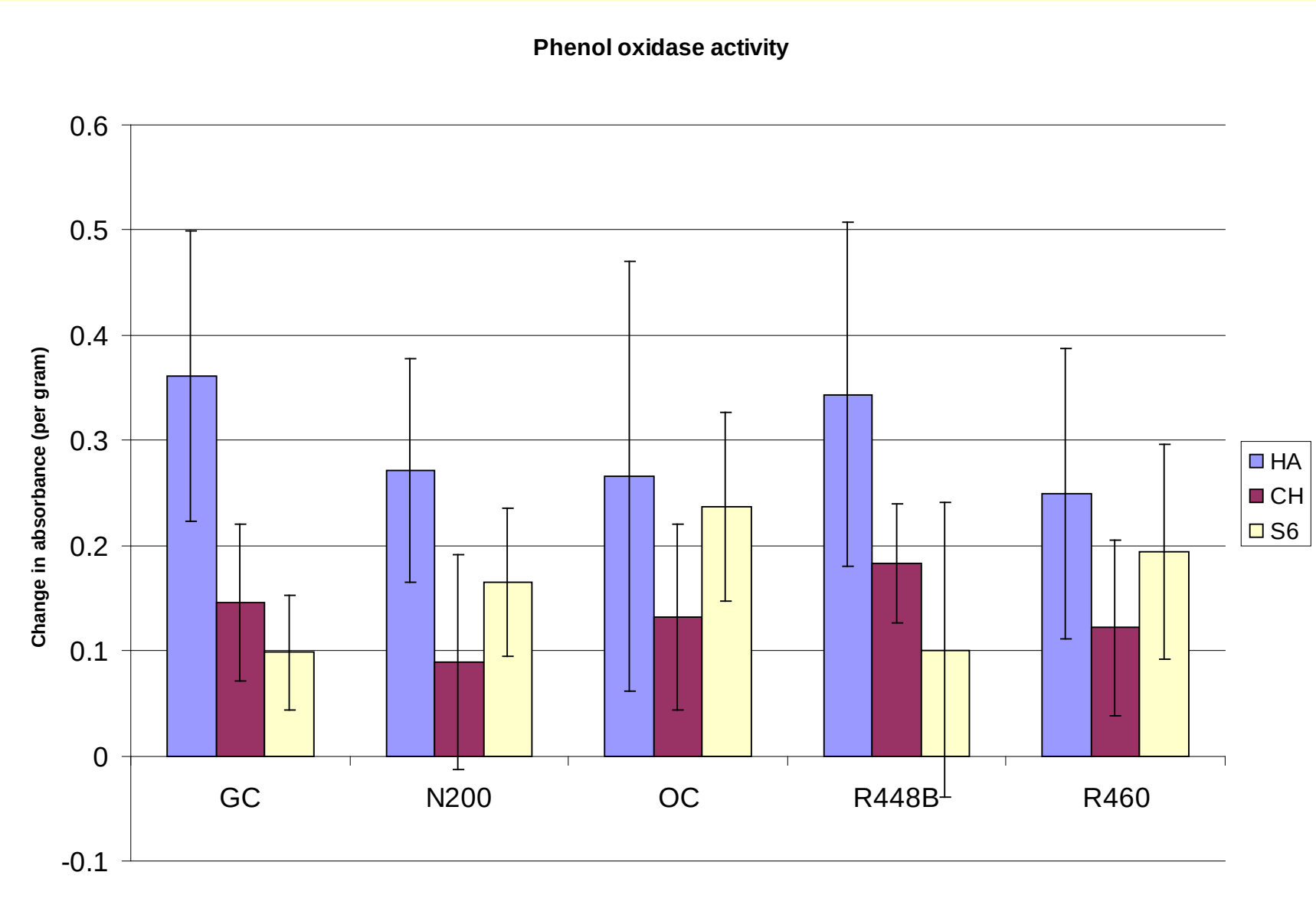
Different site ?

Testing the excess moisture hypothesis



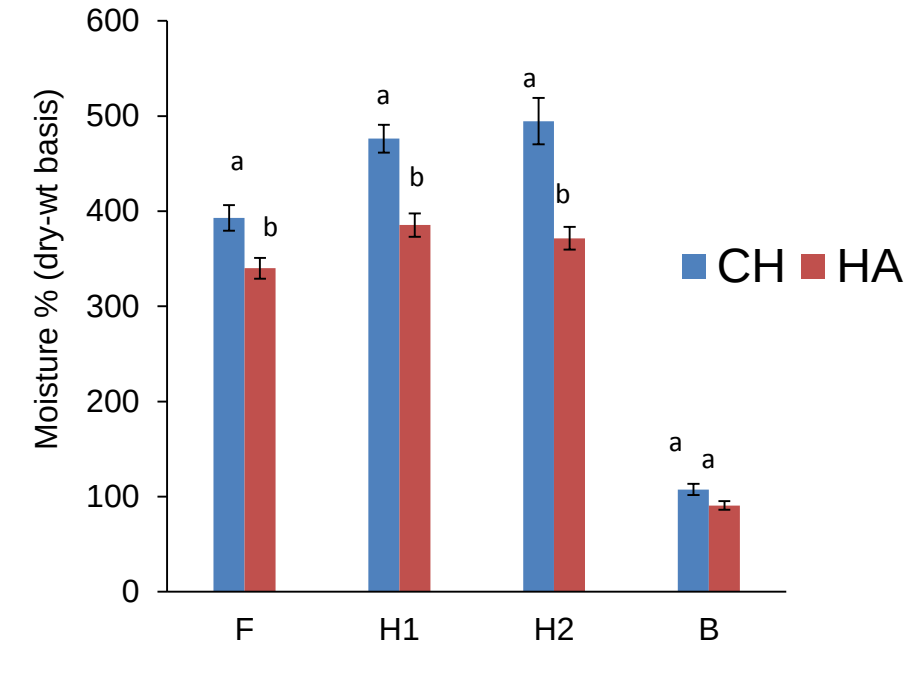

Proportion of total rod length sampled that was anoxic
1.0
0.8
0.6
0.4
0.2
0.0
HA
CH
S6
S6 > CH > HA
p<0.0001
Beaver L.
GC
M1200
N200
OC
R448
R460

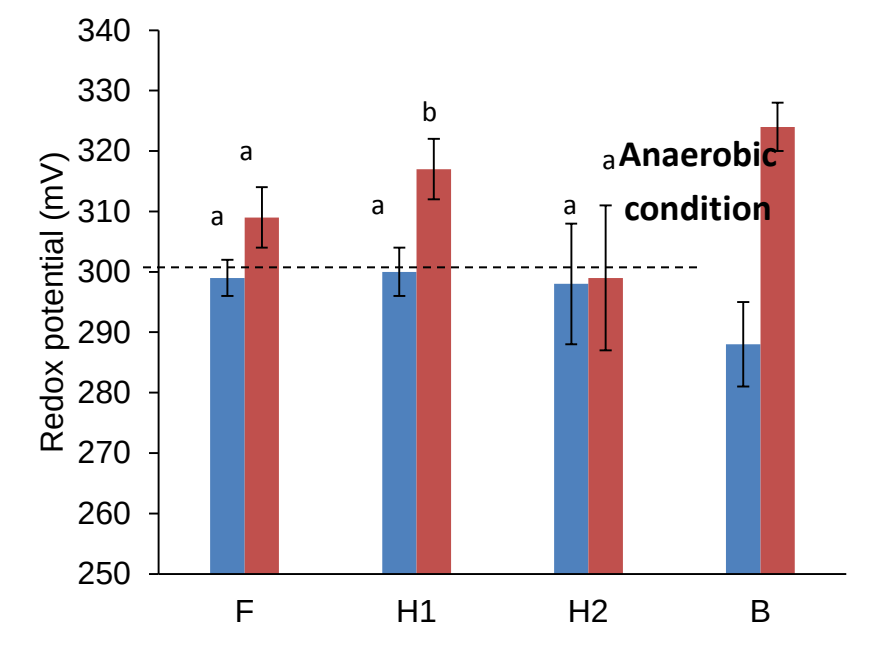

Proportion of total forest floor sampled that was anoxic
1.0
0.8
0.6
0.4
0.2
0.0
HA
CH
S6
S6 > CH, HA
p<0.0001
Beaver L.
GC
M1200
N200
OC
R448
R460


Phenol oxidase activity
Change in absorbance (per gram)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
GC
N200
OC
R448B
R460
HA
CH
S6

Soil moisture and aeration

CH forests were wetter and less aerated than HA forests

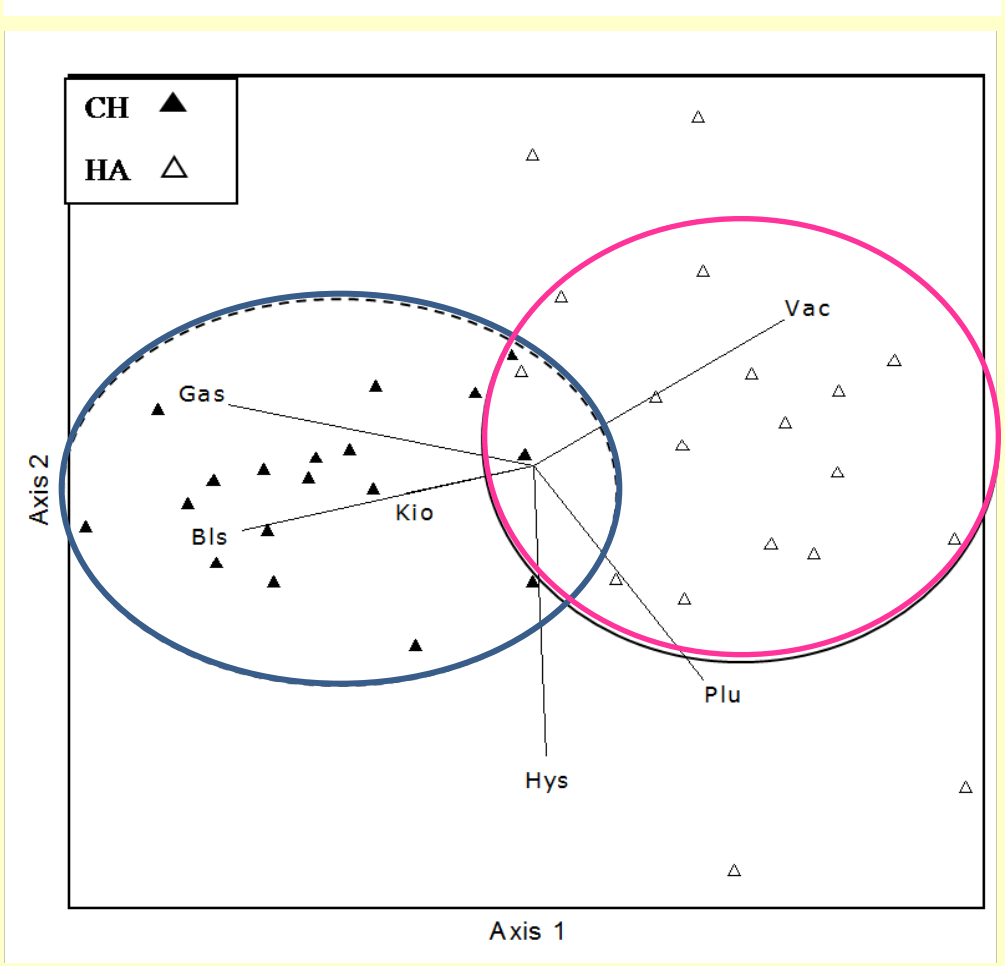




More than 40% of the sampling plots in CH forests had an average redox value less than +300 mV

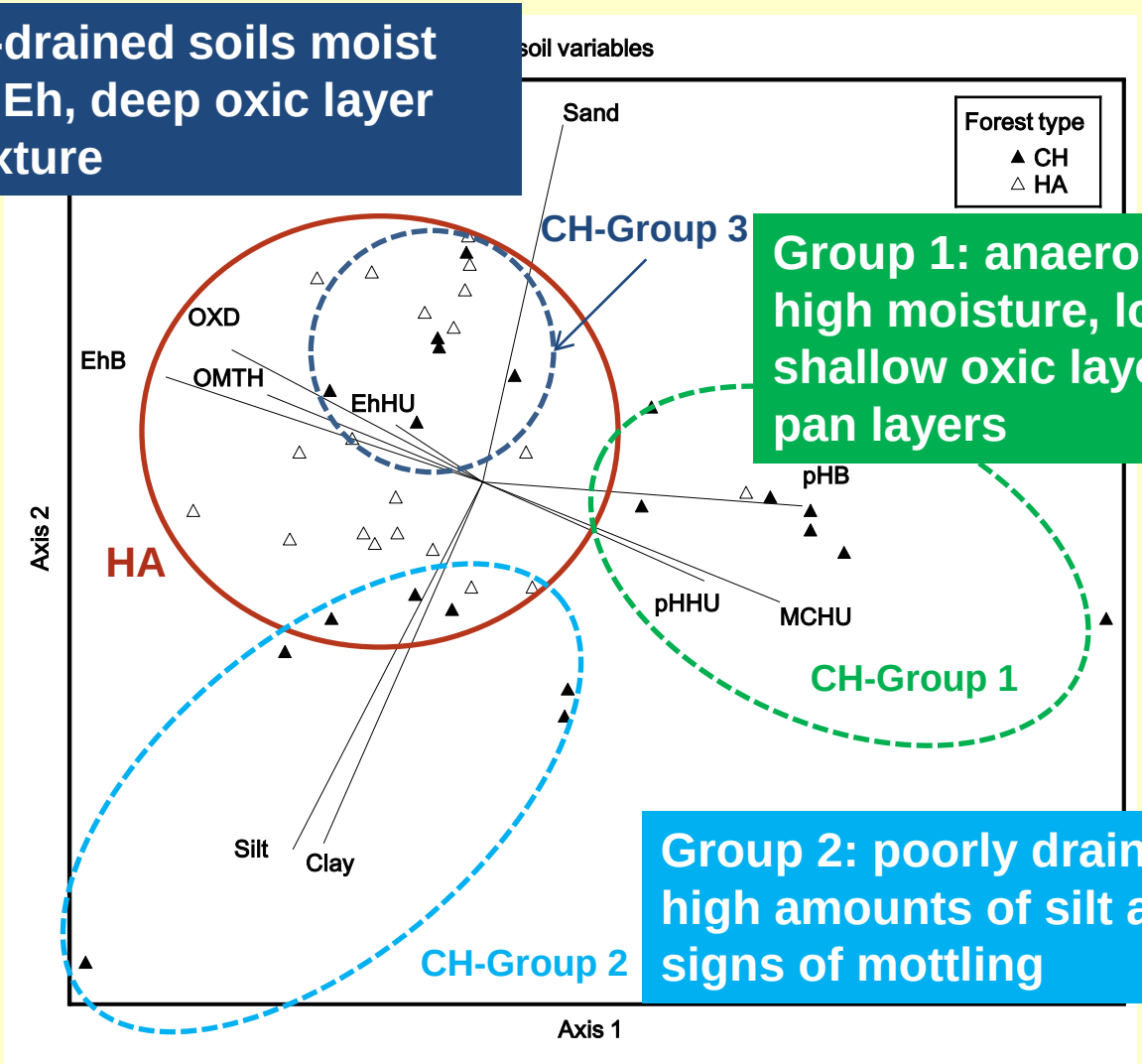
Vegetation

Distinct communities of understory plant species on CH and HA sites



Soil properties on CH and HA sites

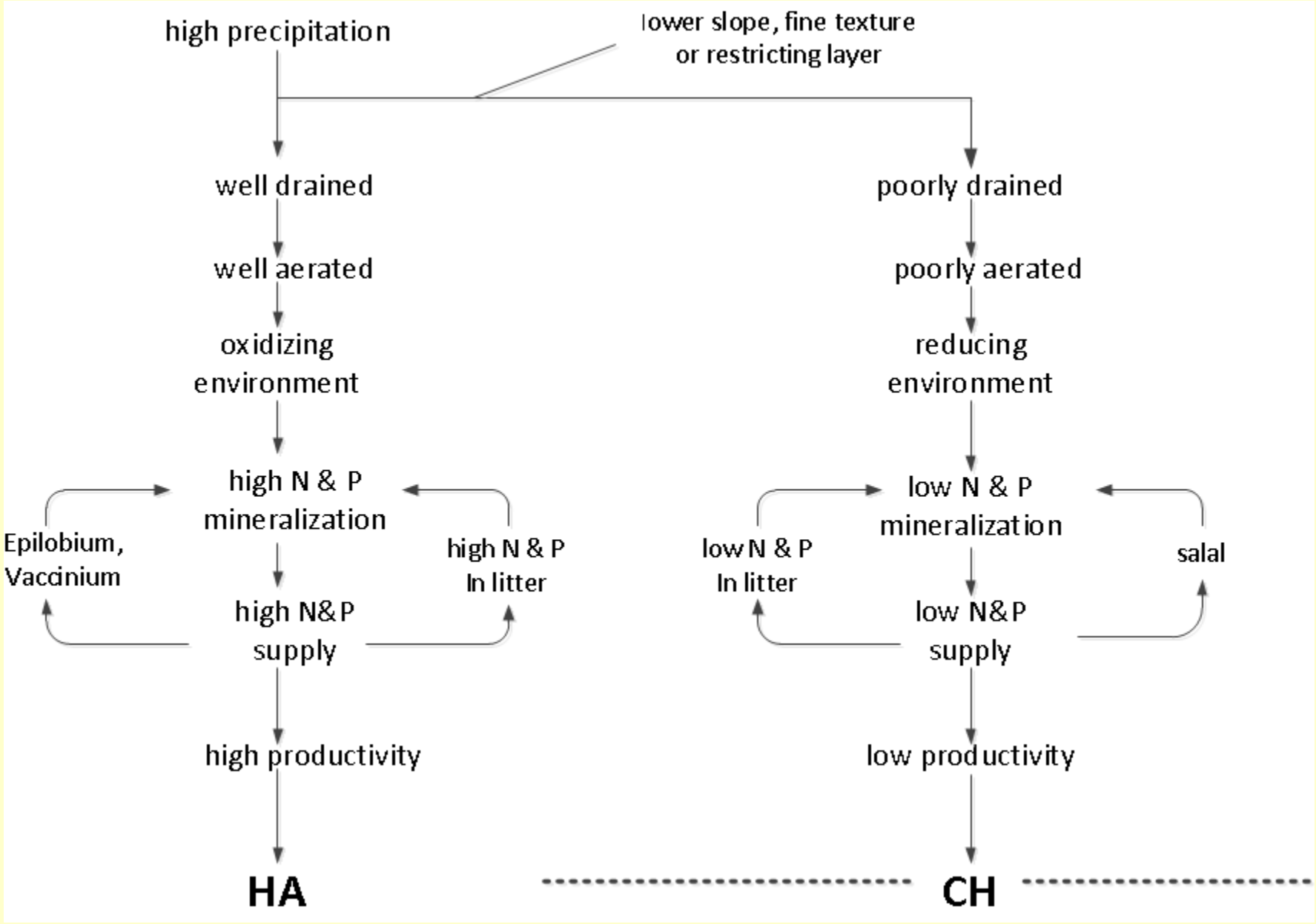
Group 3: well-drained soils moist soils, highest Eh, deep oxic layer with sandy texture



Group 1: anaerobic soils with high moisture, lowest Eh and shallow oxic layer caused by pan layers

Group 2: poorly drained soils with high amounts of silt and clay and signs of mottling

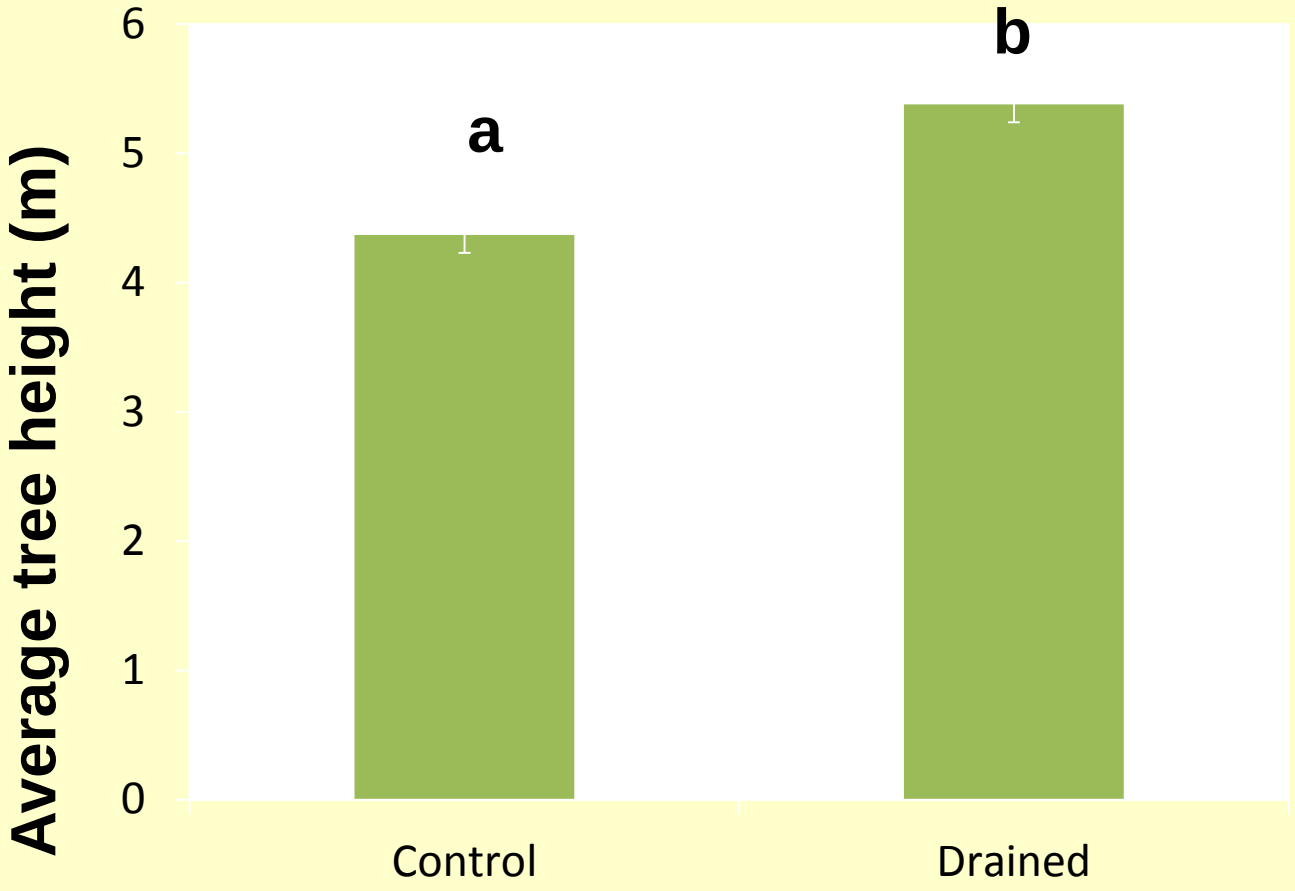
Sajedi et al 2012 J. Ecology 100: 605–618


high precipitation
lower slope, fine texture
or restricting layer
well drained
well aerated
oxidizing
environment
high N & P
mineralization
Epilobium,
Vaccinium
high N & P
In litter
high N&P
supply
high productivity
HA
poorly drained
poorly aerated
reducing
environment
low N & P
mineralization
low N & P
In litter
salal
low N&P
supply
low productivity
CH

Drainage trial

Drainage trial

Drainage significantly improved growth of regenerating trees



Conclusions

- Low nutrient supply on CH sites arises from excessive moisture and associated poor aeration
- Drainage is the only means of fundamentally improving CH sites
- Productivity of regenerating conifers on CH cutovers can be improved be repeated additions of N and P (to level equivalent to HA cutovers)
- Stand volume responses to fertilization are greater on the more fertile (HA) sites