

Vegetation Management in PNW Reforestation Projects

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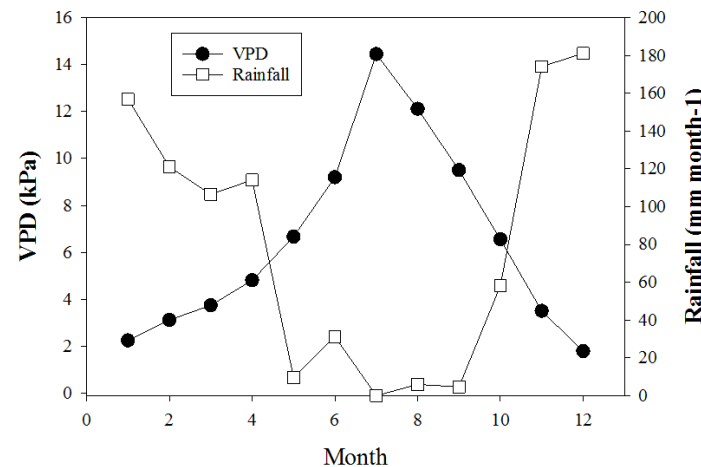
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Herbicide Use in PNW Forestry



Herbicides are a necessary part of most reforestation projects in the PNW due to:

- The Mediterranean climate of the region making competition for soil water resources intense during the dry summer months. → seedling mortality or reduced growth
- Presence of long lived and difficult to control woody tree and shrub species. → Long-term impacts
- Reduced competition during stand establishment has a long-term impact on the growth of our long rotation crop trees.
- The lack of an effective and economical alternative to herbicides.



Herbicide Use in PNW Forestry



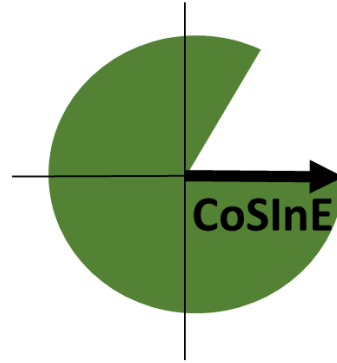
Chemical vegetation management treatments create a **temporal reduction** in the amount of competing vegetation, which allows the newly planted stand to better capture site resources. **Reduced competition** increases planted seedling survival and growth.

Typical Reforestation Regime

Fall Site Preparation → Fall/Winter Tree Planting → Spring Release Treatment (x2)



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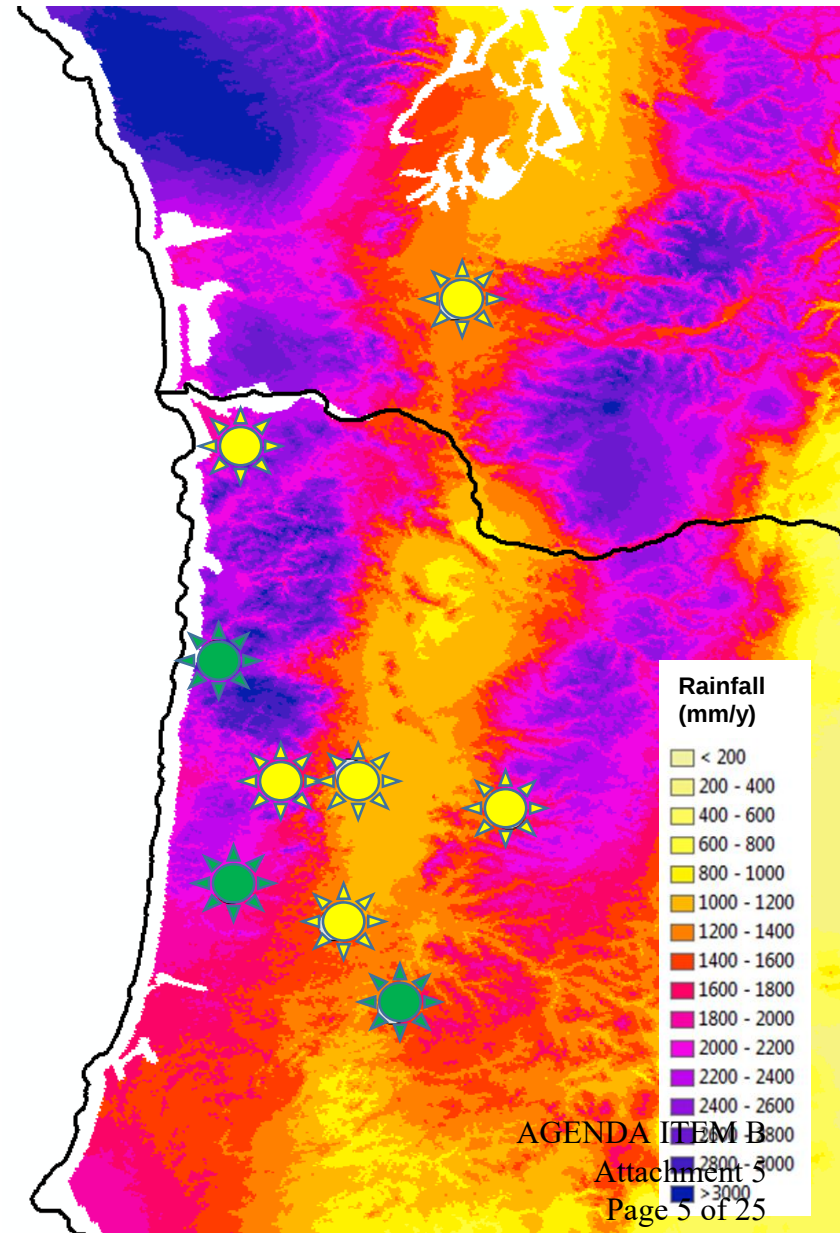
CoSInE

Competition x Site Interactions Experiment

CoSInE Study Network

Evaluate the influence of a **common set of VM** treatments on conifer seedling survival, growth and ecophysiological responses **across a wide range of site** conditions. The treatment design is a 2 x 2 x 2 factorial.

Treatment	Fall site	Spring Release	Spring Release
Type	Preparation	Growing Season 1	Growing Season 2
1 (000)	0	0	0
2 (010)	0	1	0
3 (001)	0	0	1
4 (011)	0	1	1
5 (100)	1	0	0
6 (110)	1	1	0
7 (101)	1	0	1
8 (111)	1	1	1



CoSInE Study Methods

Weather station

- Temperature [$^{\circ}\text{C}$]
- Rainfall [mm]
- Solar Radiation [W m^{-2}]
- Relative Humidity [%]

Soil moisture sensors

- Volumetric water content [$\text{cm}^3 \text{cm}^{-3}$]



Twice a year:

Seedling dry mass (leaves, stem, roots)

- Winter – Summer
- Nutritional Content

Once a year (July):

- Biodiversity at species level (richness and abundance)

Monthly (April – Oct):

- Seedling height and survival
- Vegetation cover% and height by growth habit: Fo, Fe, G, V/S, S and T
- Vegetation biomass, height and cover% by growth habit
- Seedling xylem water potential [MPa]
 - Pre-dawn
 - Mid-day

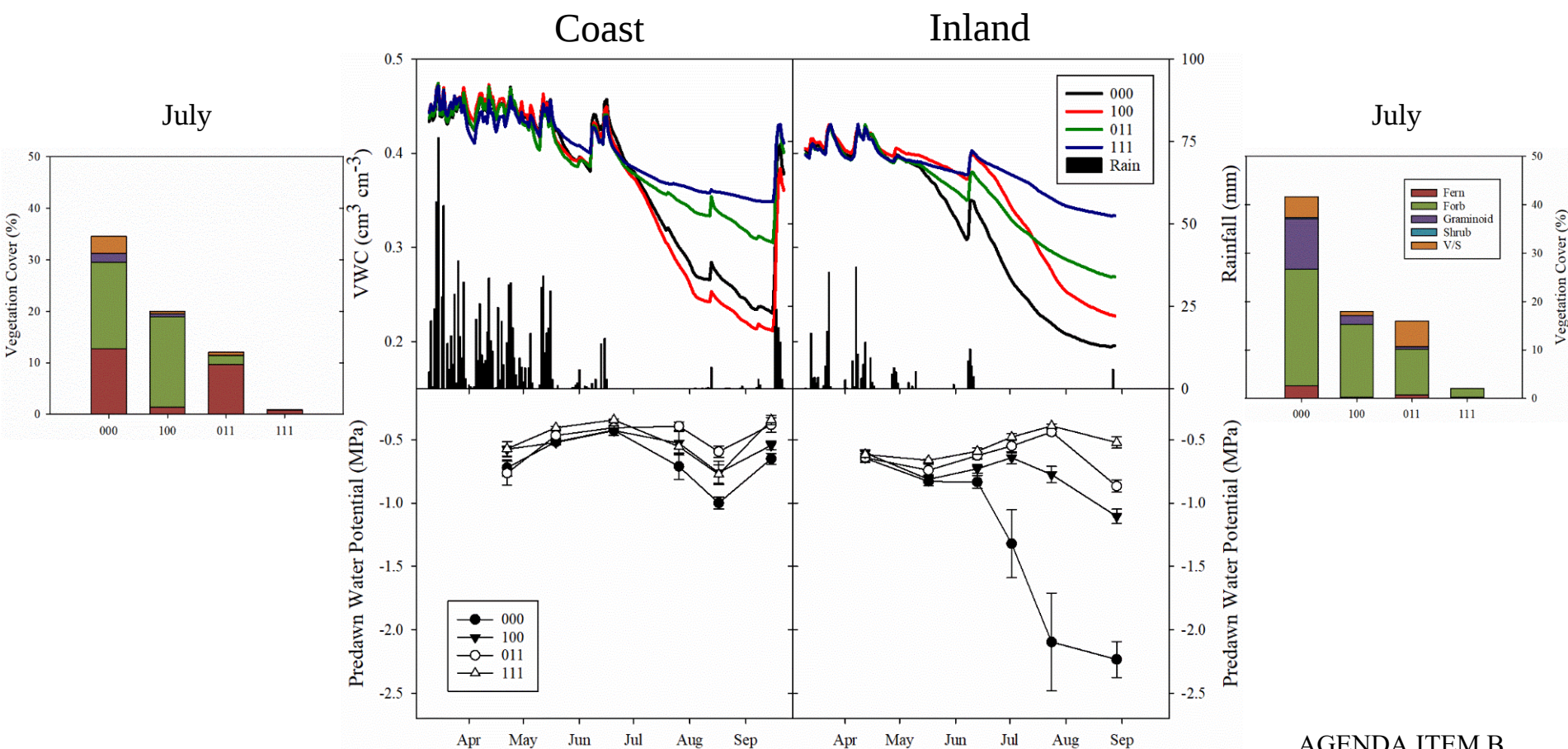


Additional measurements:

- Stem hydraulic conductivity
- Photosynthesis and stomatal conductance
- Fluorescence

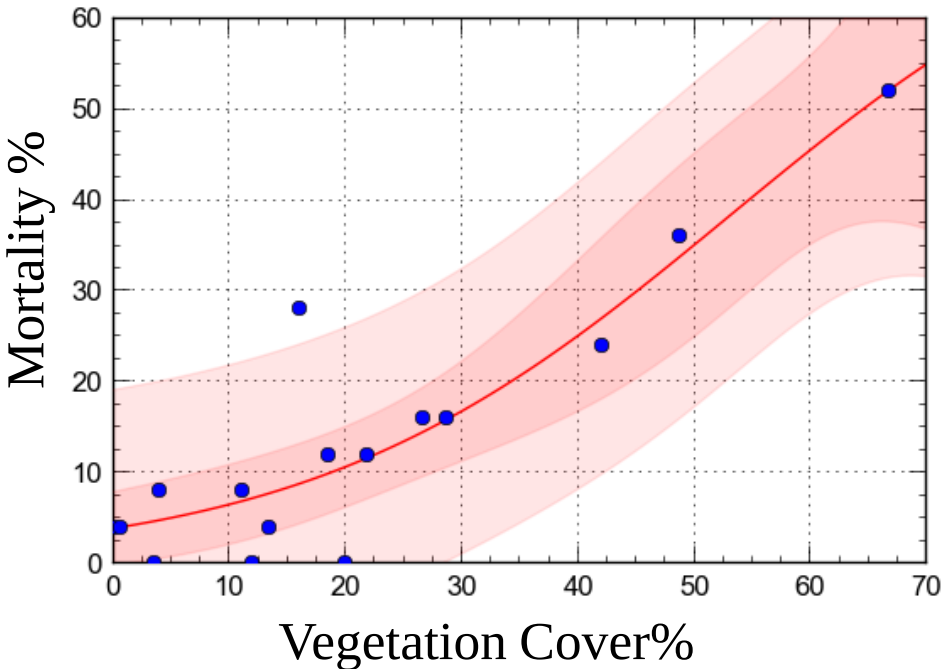
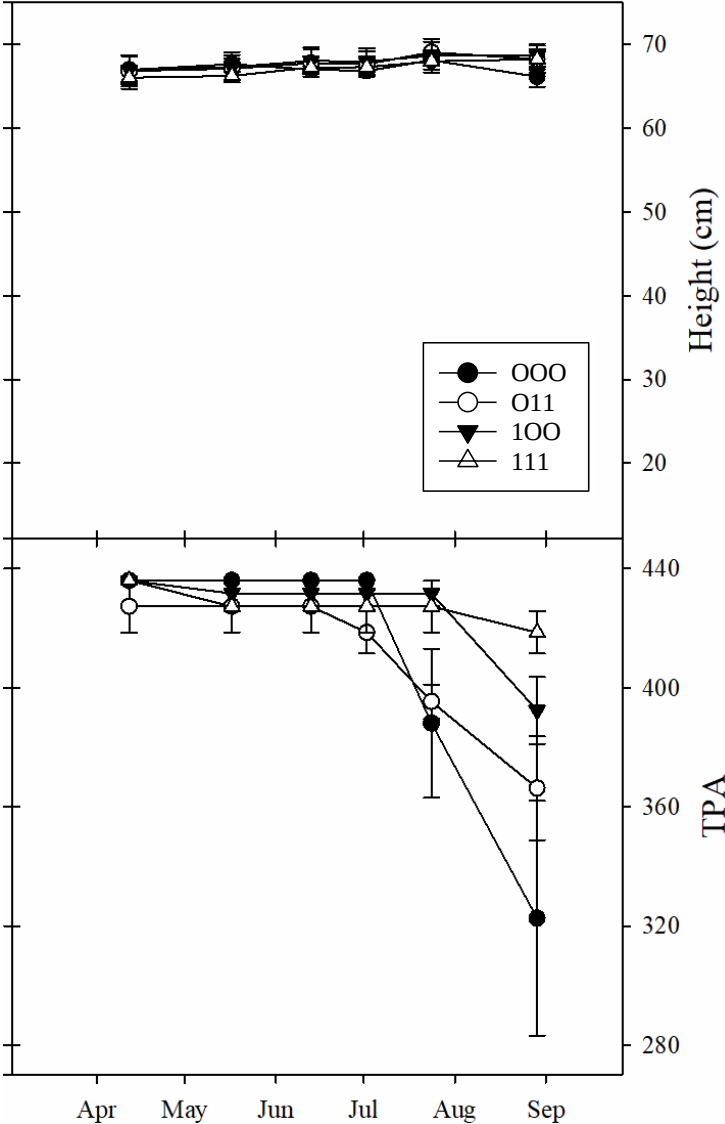
COSINE Results - Soil Moisture - Seedling Water Stress

Soil Moisture and Pre-dawn Water Potential (Growing Season 1)

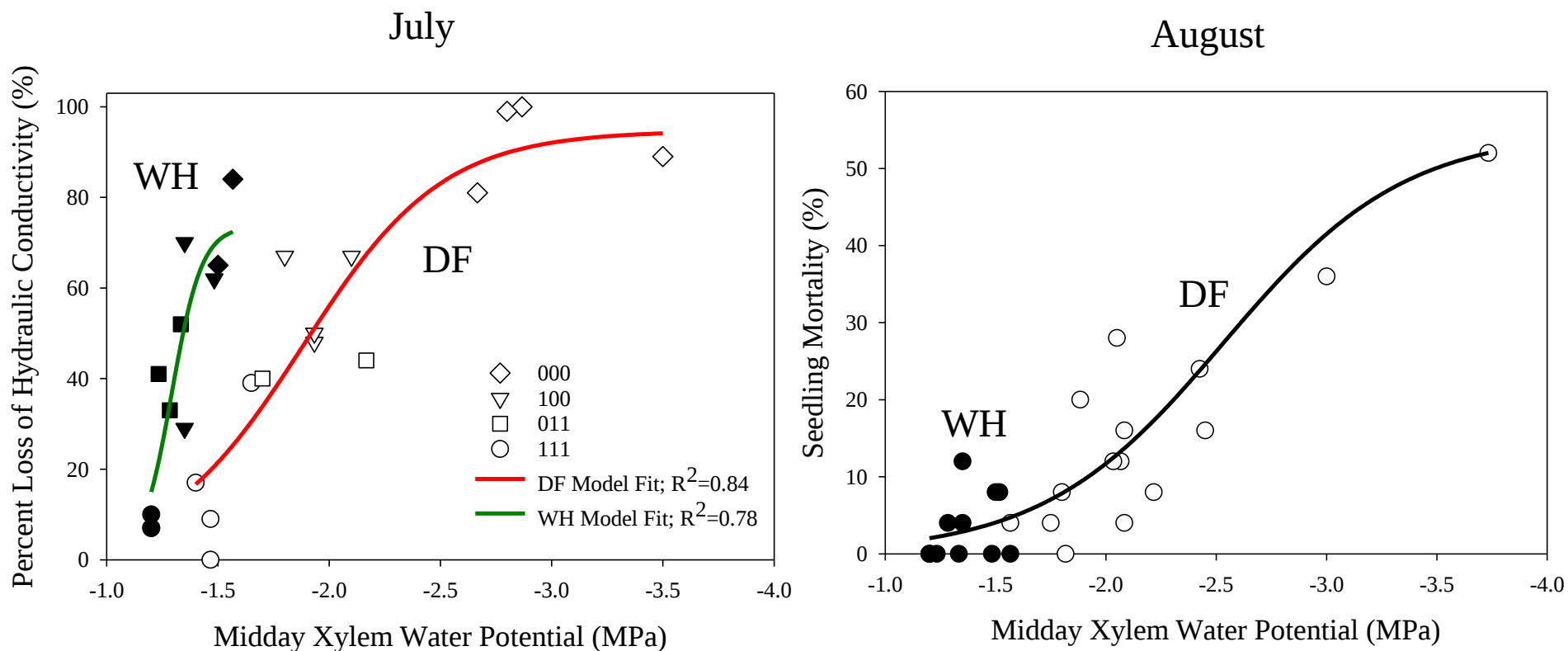


COSINE Results - Seedling Height and Mortality

Inland



COSINE Results - Seedling Height and Mortality



Competing vegetation depletes
available soil water

Increase seedling
water stress

High evaporative demand
induces cavitation

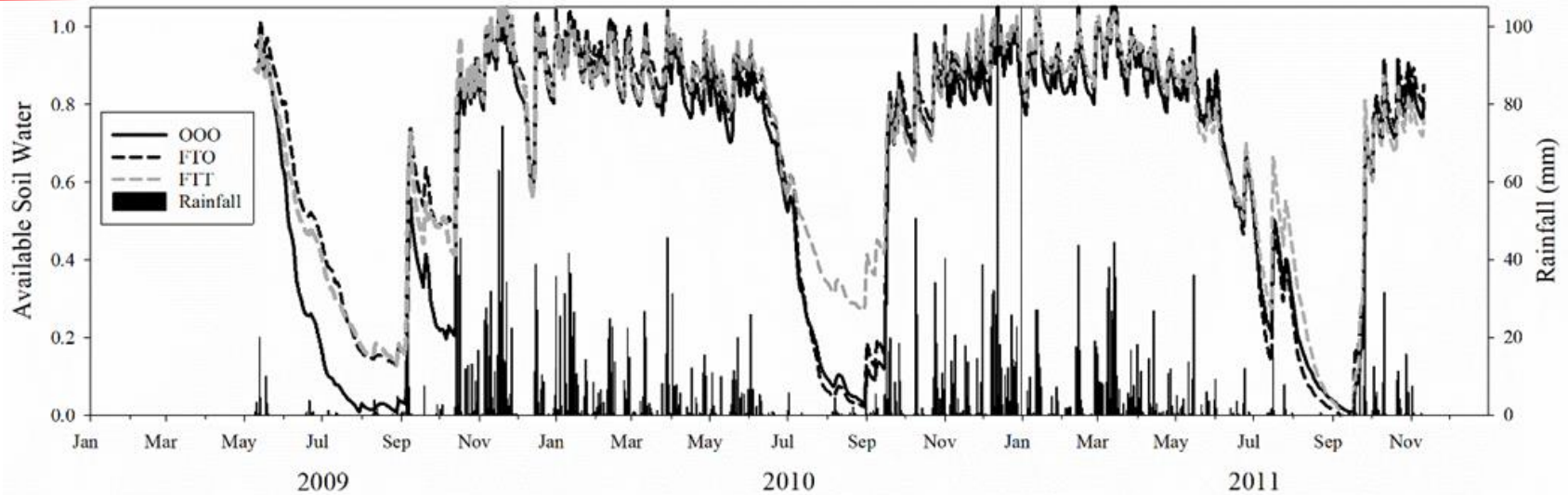
Mortality is triggered

Productivity is severely limited

- VM reduces competing vegetation cover → reduces soil water depletion → increases seedling growth and survival.
- Water stress and mortality dynamics are site specific: costal site showed little drought stress, inland sites had high drought stress.
- Understanding ecophysiology, competing vegetation dynamics and site conditions will allow us to model the response of Douglas-fir and Western hemlock seedlings to VM treatments. → Decision support system.
 - Determine site-specific thresholds of vegetation cover to ensure seedling survival
 - Determine level of growth gain by applying an additional year of VM
 - Model the early growth of young conifer plantations

Length of Vegetation Management Effects on Soil Moisture and Understory Vegetation Abundance and Richness

FVM Effects - Soil Moisture – Vegetation Cover

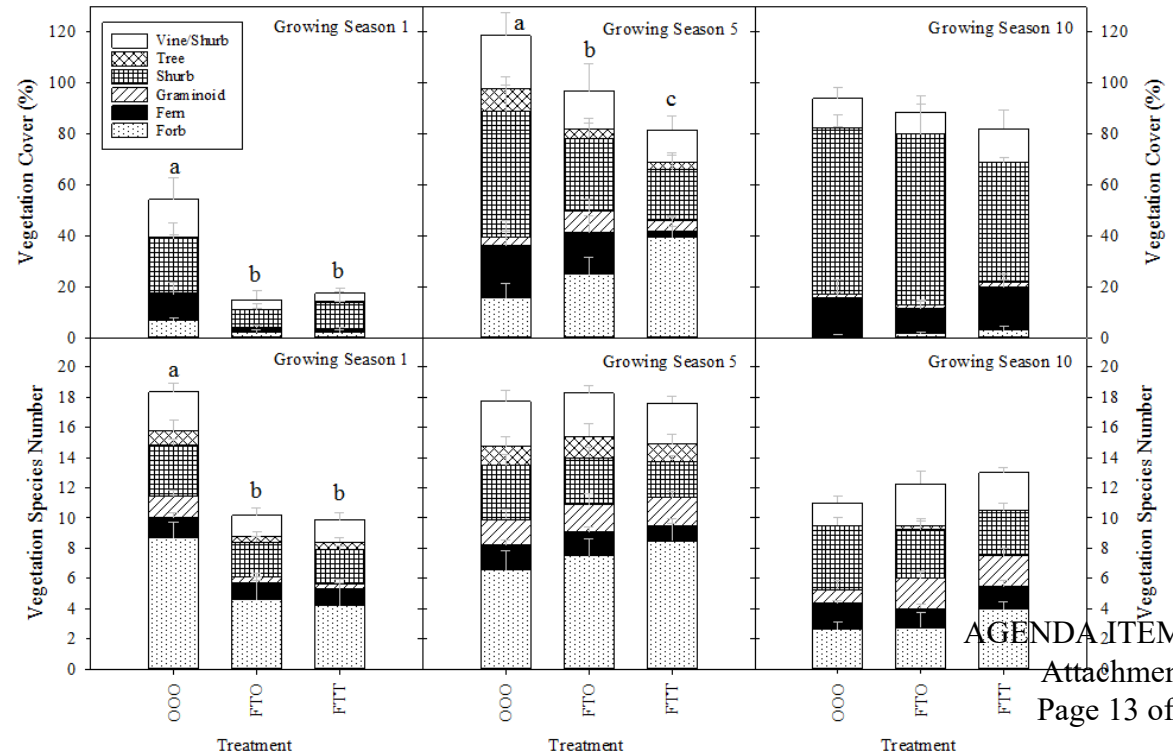
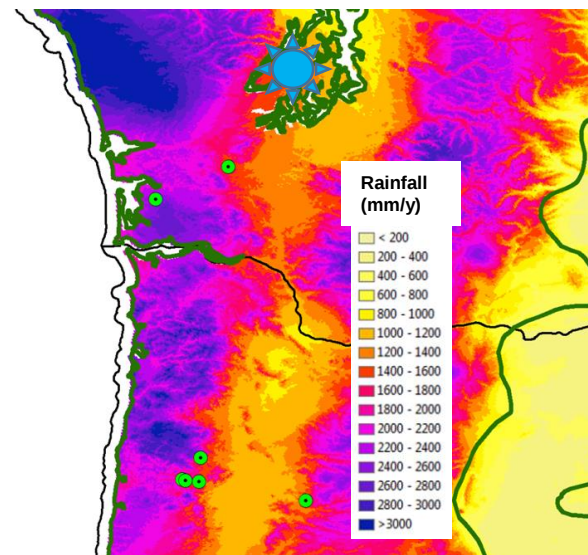


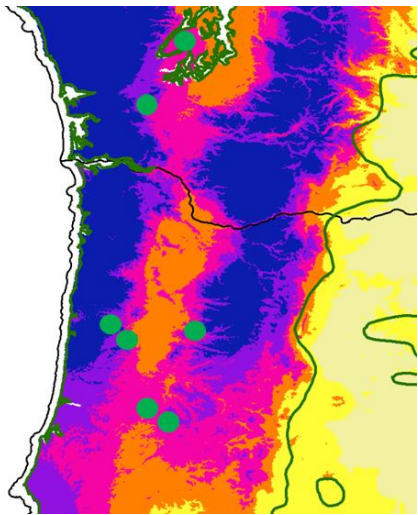
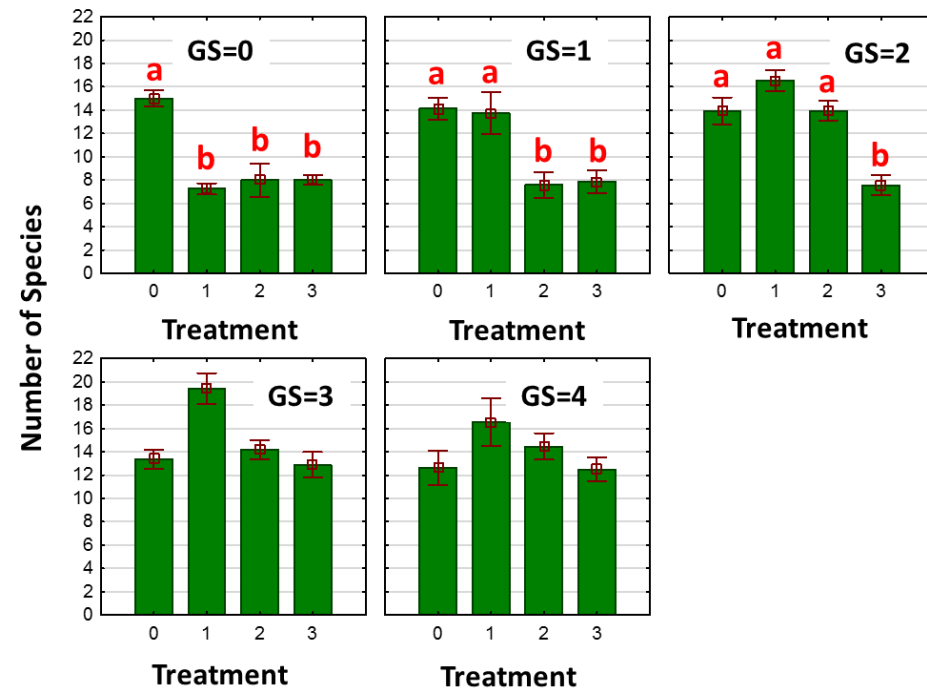
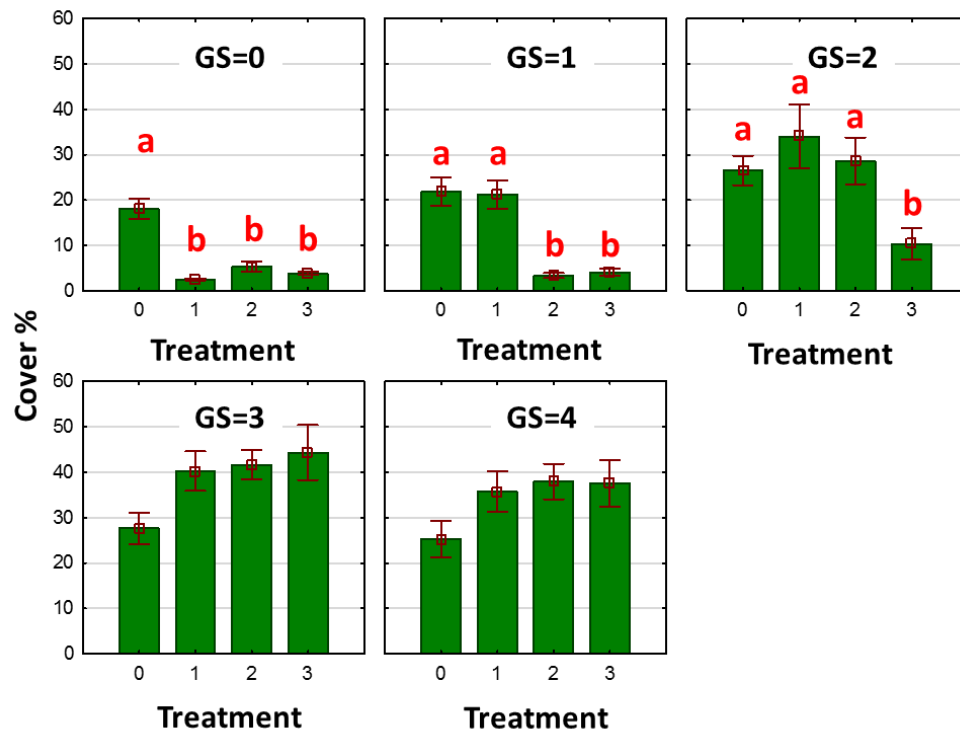
Site: Belfair, WA

Soil Texture: Very gravelly sandy loam

Mean annual temp.: 11.1 C (51.9 F)

Rainfall: 1433 mm (56.4 in)





7 study sites that vary in:

- Climatic conditions
- Soil type
- Establishment year
- Type and rates of herbicide applications

Treatments

0 : Control

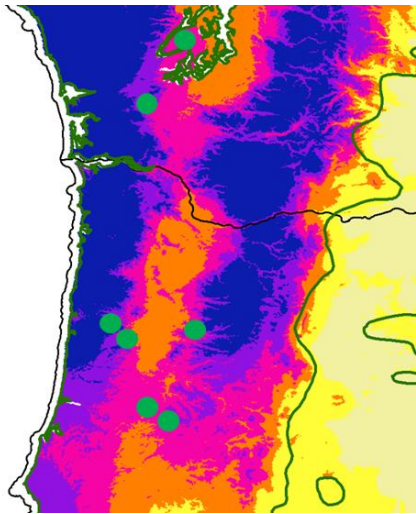
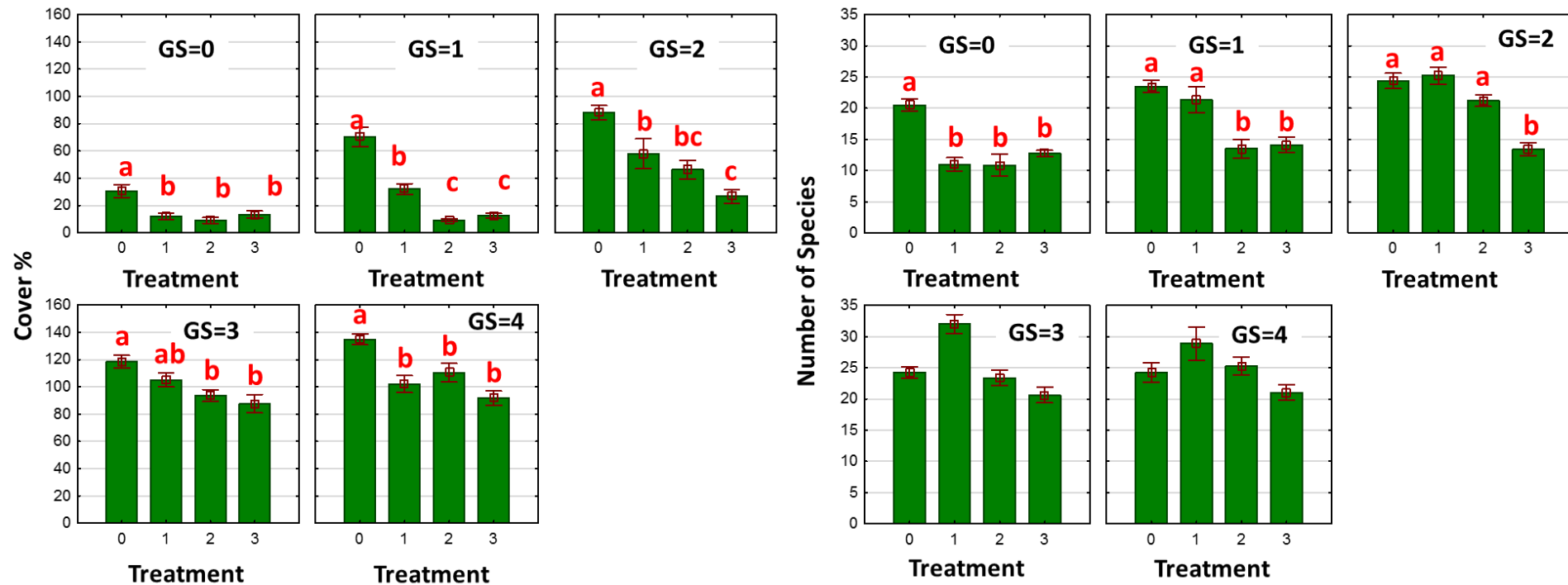
1 : FSP

2 : FSP + SR1

3 : FSP + SR1 + SR2

VM Effects on Understory Vegetation

TOTAL



7 study sites that vary in:

- Climatic conditions
- Soil type
- Establishment year
- Type and rates of herbicide applications

Treatments

0 : Control

1 : FSP

2 : FSP + SR1

3 : FSP + SR1 + SR2

VM Effects on Understory Vegetation

Growing Season when species Cover% is recovered (equals to control)

Habit	Cover % of Control at GS=4 yrs.	FSP	FSP + SR1	FSP + SR1 + SR2
Forb	25	1	2	3
Fern	23	>4	>4	>4
Graminoid	20	1	3	4
Shrub	22	>4	4	>4
Tree	7	1	2	2
V/S	37	>4	>4	>4
Total	134	>4	>4	>4

Growing Season when species richness is recovered (equals to control)

Habit	Number of spp of Control at GS=4 yrs.	FSP	FSP + SR1	FSP + SR1 + SR2
Forb	13	1	2	3
Fern	1-2	-	-	-
Graminoid	3	1	3	4
Shrub	3	-	-	-
Tree	1-2	-	-	-
V/S	2	3	3	3
Total	24	1	2	3



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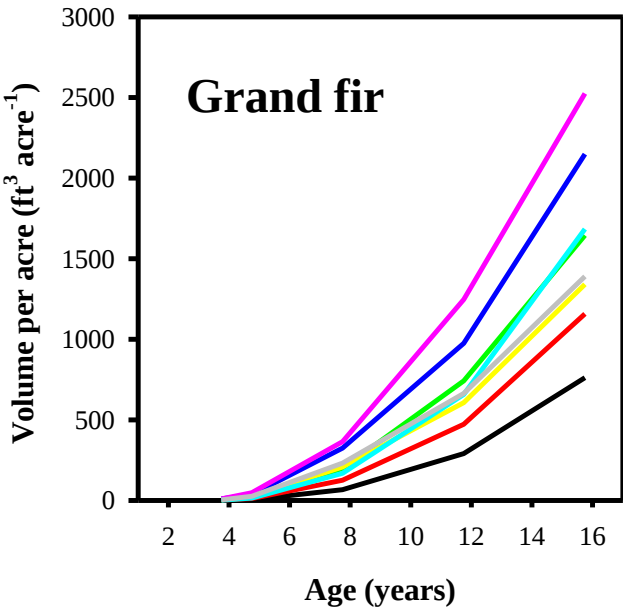
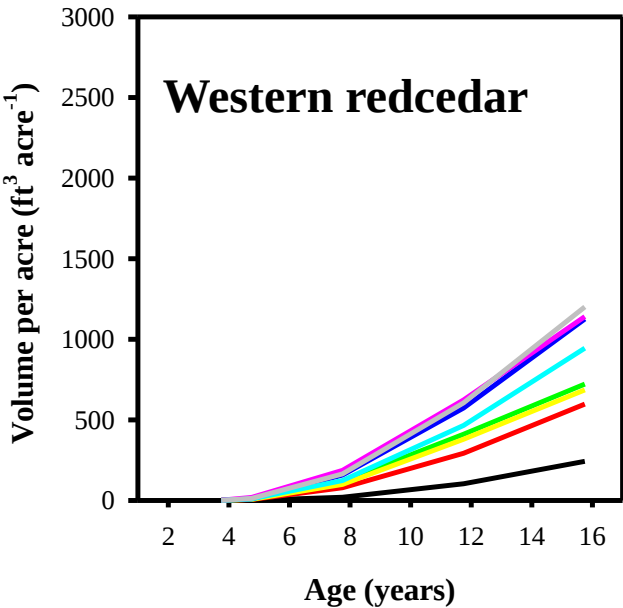
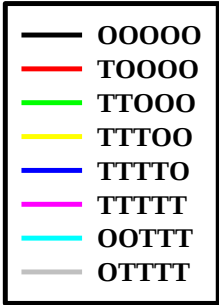
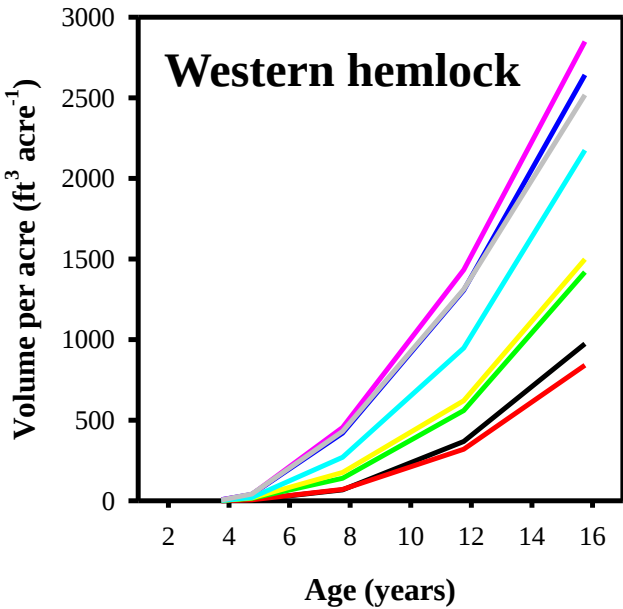
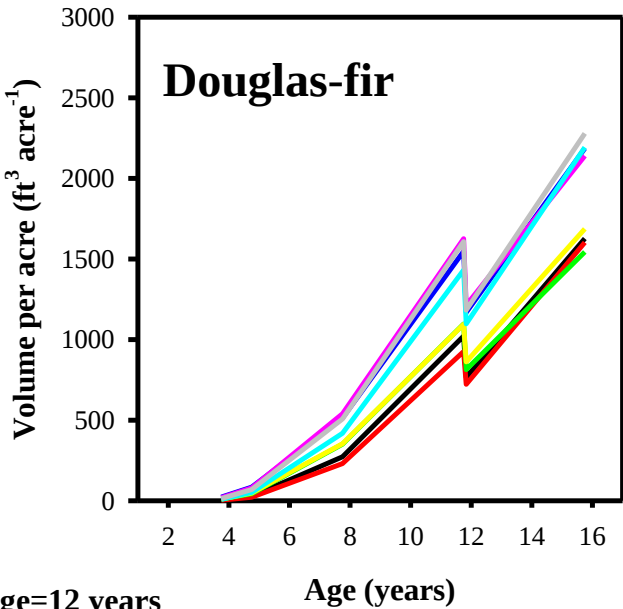


Long-term Effects of Vegetation Management on the Biomass Stock and Net Primary Productivity of Four Coniferous Species in the PNW

FVM Effects -

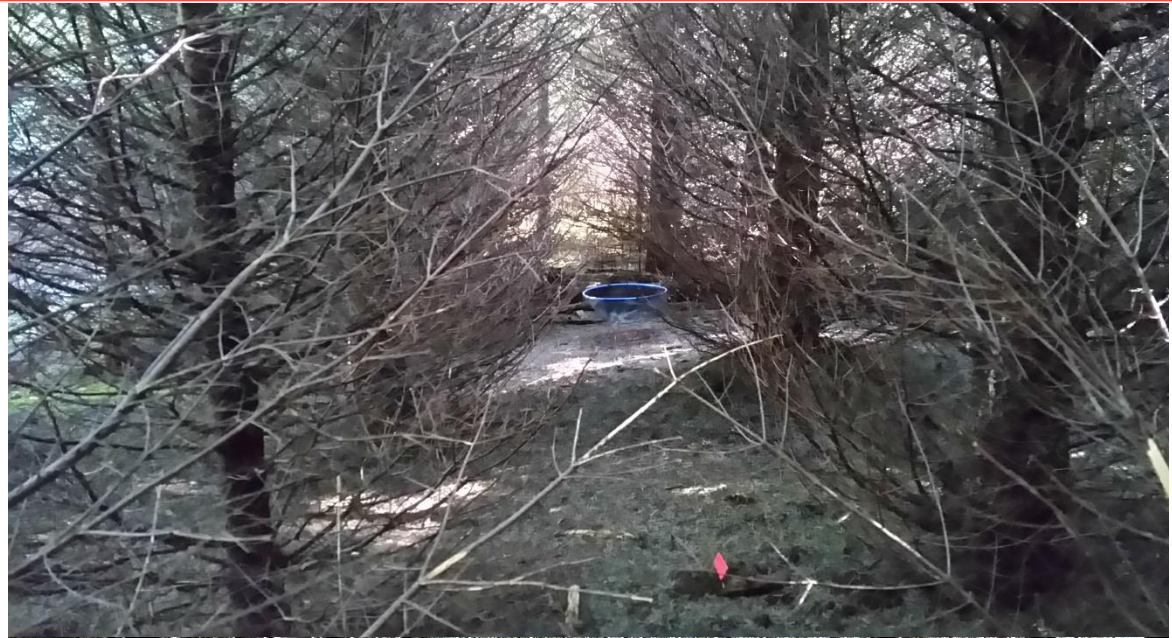
Stem Volume

CR



Background

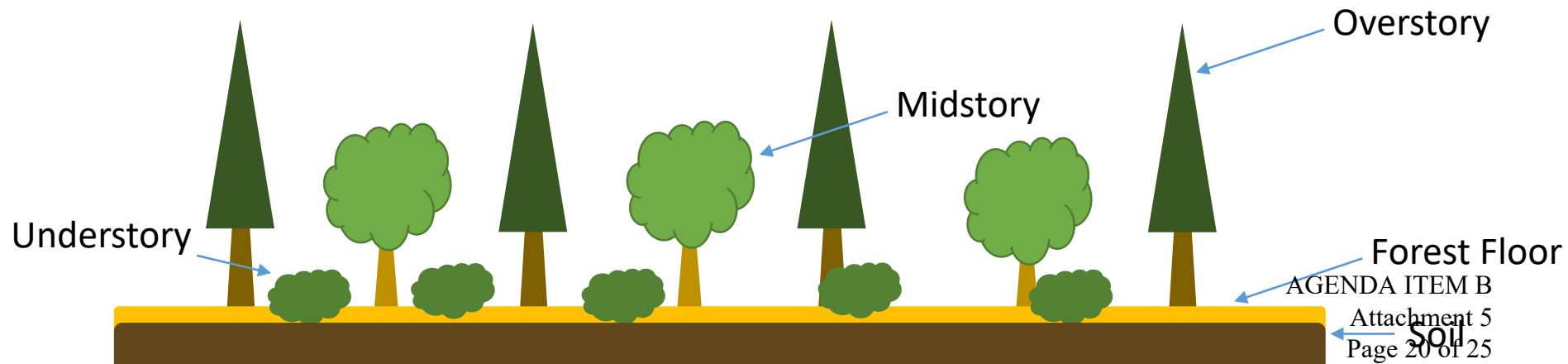
- The VMRC has two contrasting study sites, one in the Coast Range (CR) and one in the Cascade foothills (CF), with a wide range of vegetation management treatments that have created large differences in stand and ecosystem structure over the last 18-19 years.



Research Objectives

Determine the effect of crop species, VM treatment, and site on:

- 1) Overstory (crop tree) biomass stock
- 2) Understory, midstory, and forest floor biomass
- 3) Soil organic matter content
- 4) Total ecosystem biomass
- 5) Overstory (crop tree) and vegetation litterfall
- 6) Overstory (crop tree) Net Primary Productivity
- 7) Total ecosystem Net Primary Productivity



FVM Effects on Biomass Stock of PNW Conifer Plantations

● Coast Range (CR)

Study ID: CPT01

State: OR

County: Benton

Planting year: 2000

Soil Texture: Fine-loamy

Mean annual temp.: 11.1 C

Annual rainfall: 1707 mm

Species:

- Douglas-fir
- Western hemlock
- Western redcedar
- Grand fir

● Cascade Foothills (CF)

Study ID: CPT02

State: OR

County: Linn

Planting year: 2001

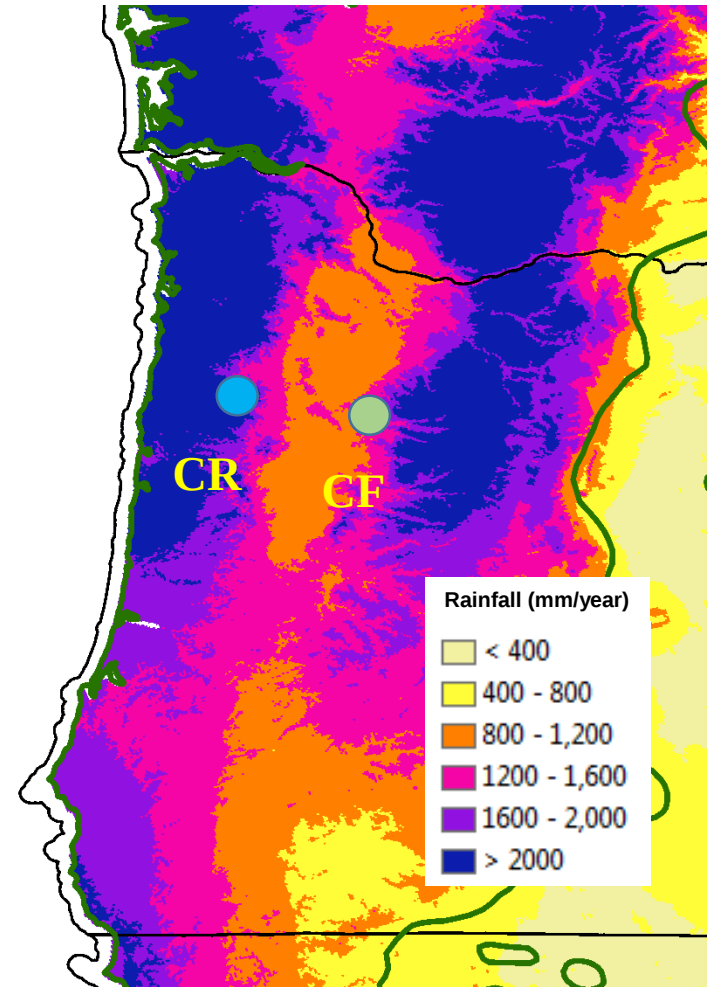
Soil Texture: silty-clay-loam

Mean annual temp.: 12.4 C

Annual rainfall: 1179 mm

Species:

- Douglas-fir
- Western redcedar



Treatments

- Control (C): Fall Site Prep only
- Vegetation Management (VM): 5 years of competition control

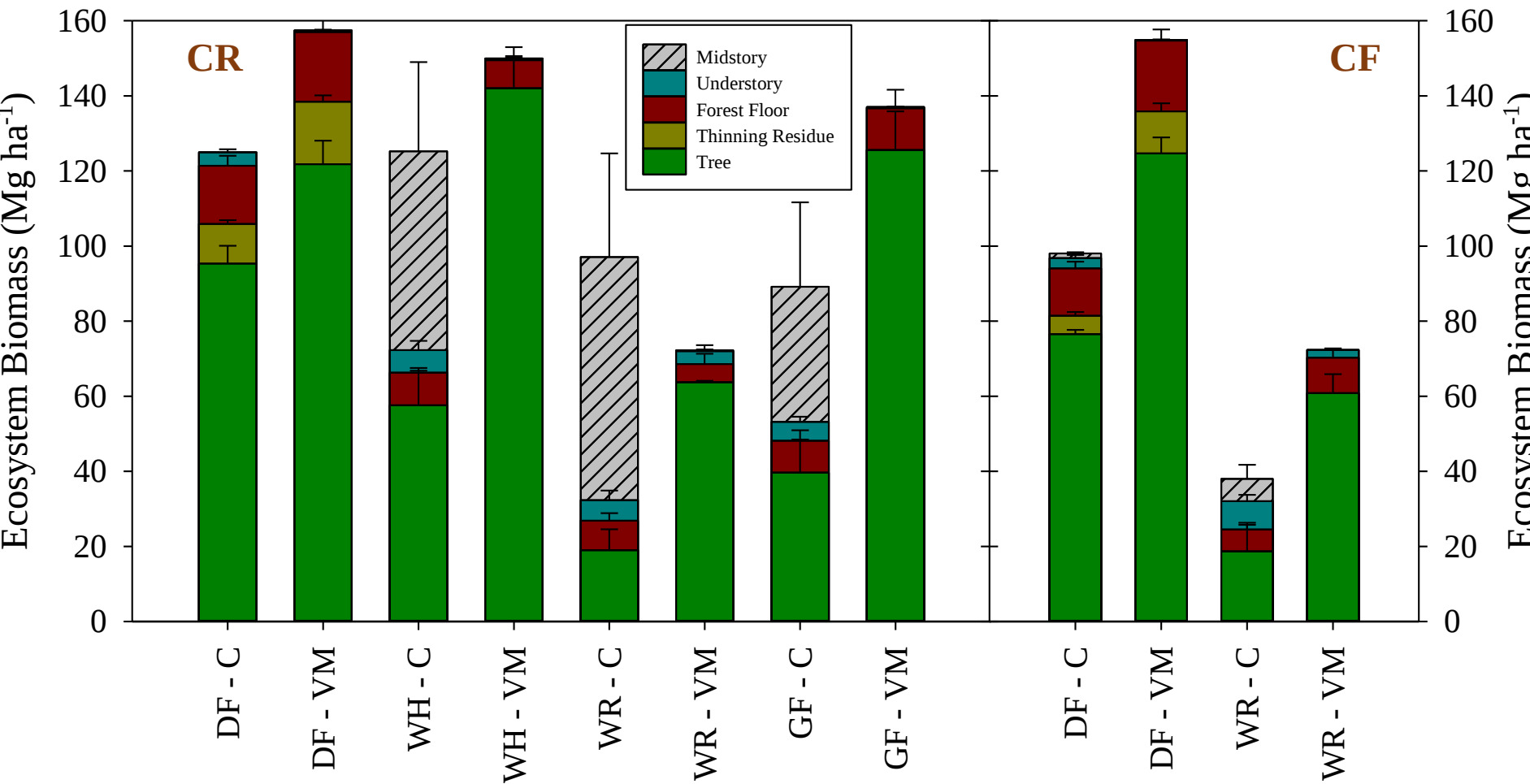
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FVM Effects -

Biomass Stock



Age 16 years

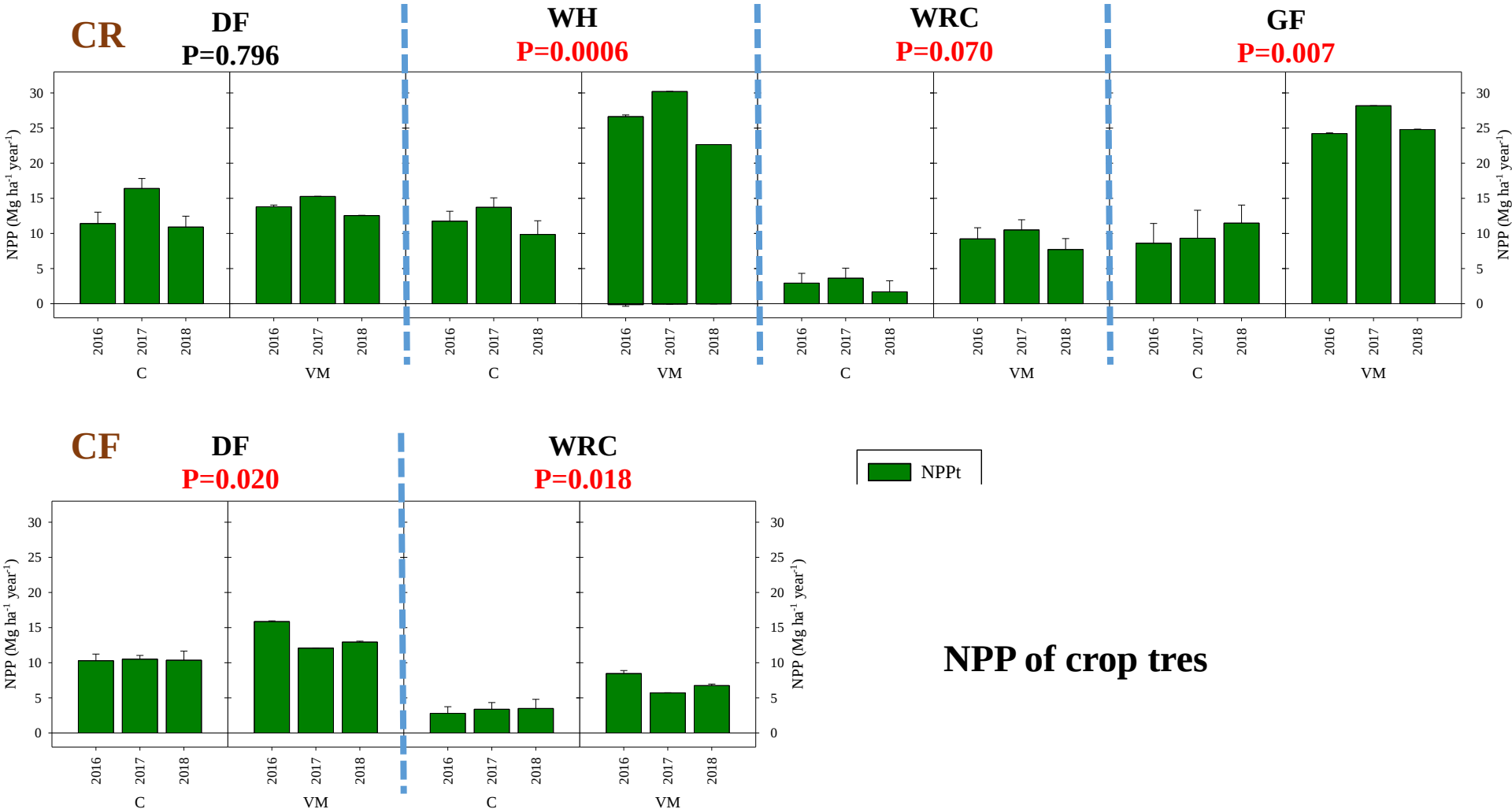
C: Control (Fall Site Prep only)
VM: Vegetation Management
(5 years of competition control)

	CR				CF	
	DF	WH	WRC	GF	DF	WRC
Crop Tree	0.009	0.001	0.001	0.003	<0.0001	0.002
Ecosystem	0.005	0.281	0.282	0.133	<0.0001	0.016

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FVM Effects -

NPP ~ Carbon Sequestration



C: Control (Fall Site Prep only)

VM: Vegetation Management (5 years of competition control)

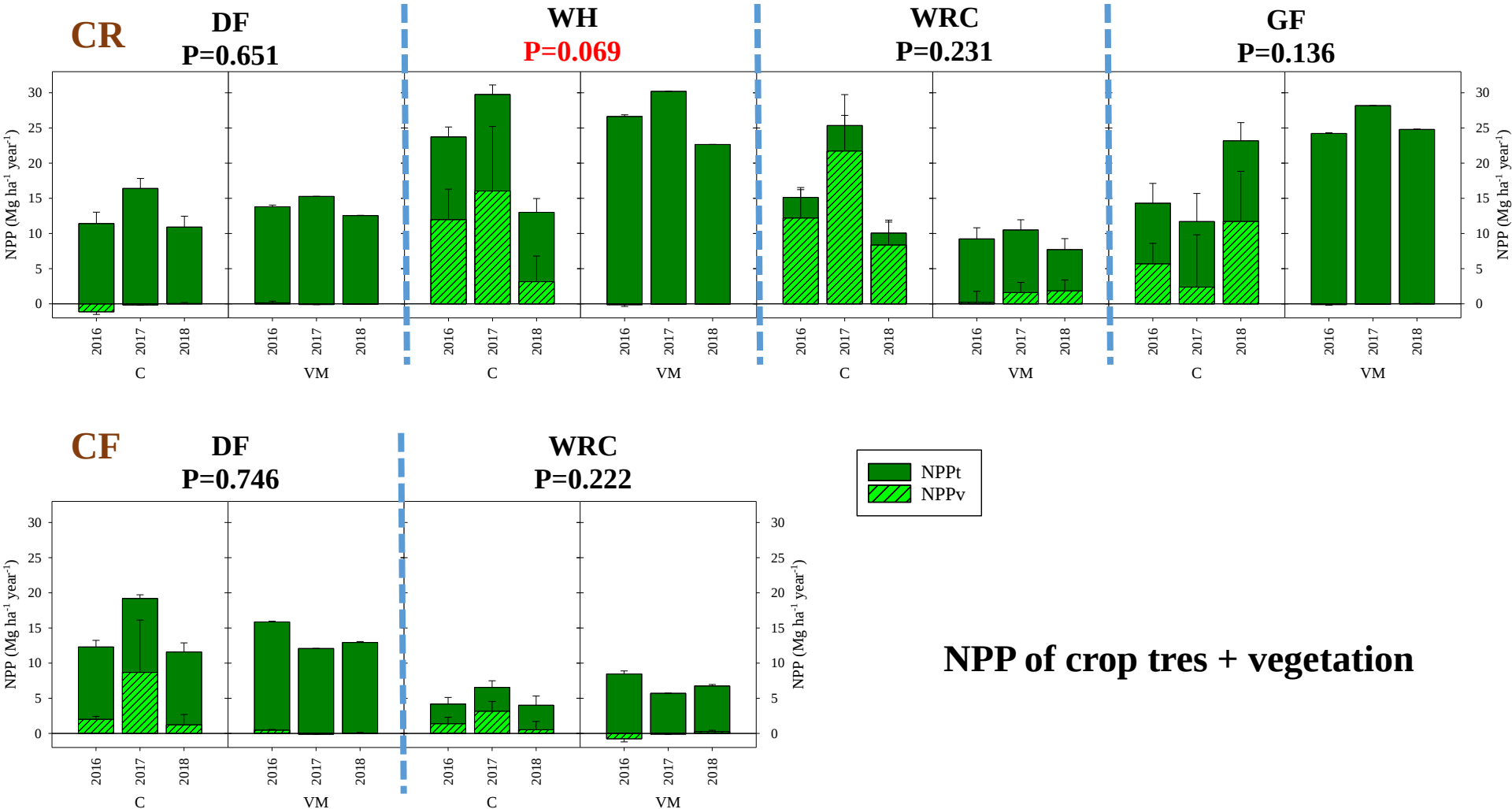
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FVM Effects -

NPP ~ Carbon Sequestration



C: Control (Fall Site Prep only)

VM: Vegetation Management (5 years of competition control)

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Thanks !!



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