PNW Forest Vegetation Management Conference

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Vegetation Management Research Cooperative Update

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Presentation Outline

a) Introduction (5 min)
   i) VMRC
   ii) **CoSInE** Project

b) Effects of FVM on Vegetation Abundance and Diversity : (20 min)
   i) Coastal Site
   i) Inland Site
   ii) 10 sites across OR and WA

c) Effects of FVM on Ecosystem Biomass and Nitrogen Stock: (15 min)

Questions/Discussion (10 min)

Vegetation Management Research Cooperative

- Stakeholder driven research organization established in 1993.

- Membership includes both private forest management companies and public land management agencies.

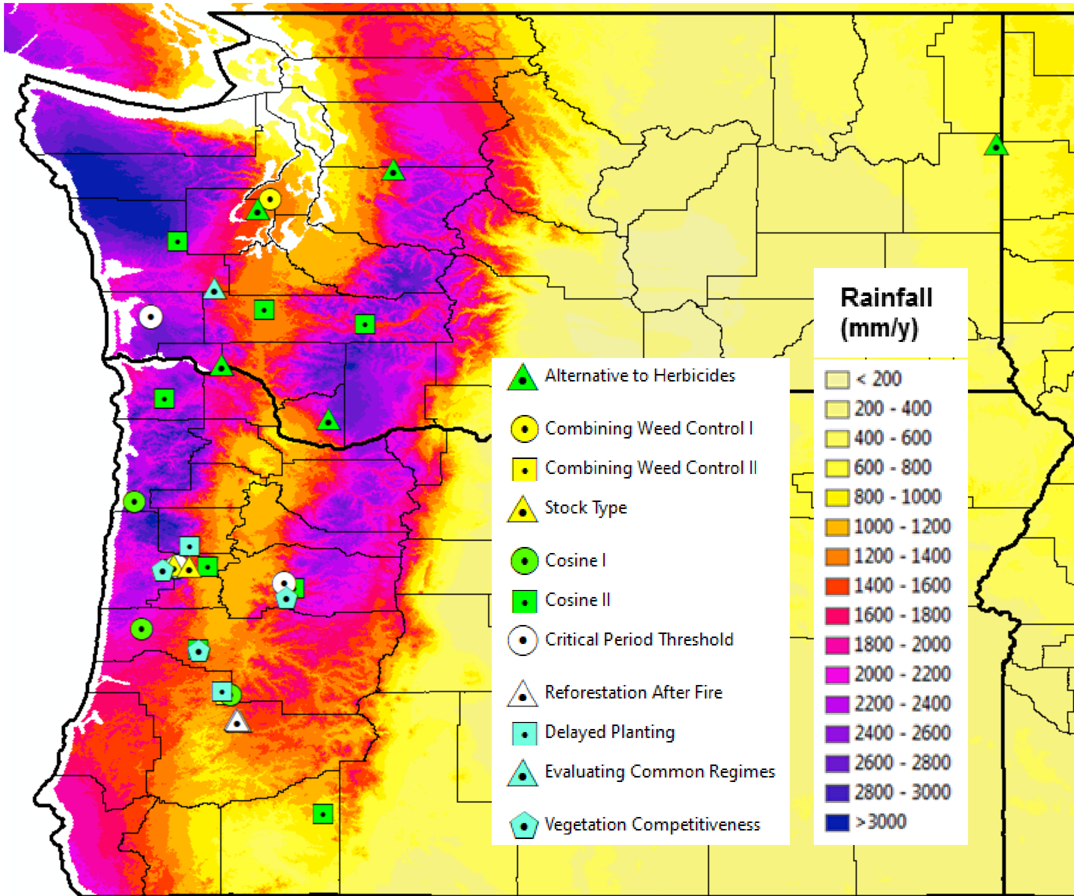
Mission

- Conduct applied reforestation research of young plantations from seedling establishment through crown closure with an emphasis on operational vegetation management.

- Promote reforestation success such that survival, wood-crop biomass and growth are maximized while protecting public resources.

VMRC

Site Name	Study Name	Year	County	State
Belfair	Combining Weed Control I	2009	Mason	WA
Miltown Hill	Combining Weed Control II	2011	Douglas	OR
Summit	Critical Period Threshold	2000	Benton	OR
Sweet Home	Critical Period Threshold	2001	Linn	OR
South Bend	Critical Period Threshold	2012	Pacific	WA
Boot	Delayed Planting	2007	Polk	OR
Jackson Mast	Delayed Planting	2007	Lane	OR
Oakville	Evaluating Common Regimes	2005	Grays Harbor	WA
Blackies Corral	Stock Type	2009	Benton	OR
Hard Rock	Stock Type	2009	Lincoln	OR
Bulgogi	Cosine I	2016	Tillamook	OR
Mac-Dunn	Cosine II	2016	Benton	OR
Boss Hog	Cosine II	2016	Linn	OR
Whipple Hill	Cosine I	2017	Douglas	OR
Burntwoods	Cosine II	2017	Lincoln	OR
Mountain Sun	Cosine II	2018	Lewis	WA
7B Pieces	Cosine II	2018	Lane	OR
River Ranch	Cosine I	2019	Lane	OR
Camp 18	Cosine II	2019	Clatsop	OR
Bull Down	Cosine II	2020	Lewis	WA
Exhibit E	Cosine II	2021	Jackson	OR
Green Diamond	Cosine II	2023	Grays Harbor	WA
4 sites	Reforestation After Fire	2021	Douglas	OR
Custom Taylored	Alternative to Herbicides	2022	Clark	WA
Mill Creek	Alternative to Herbicides	2022	Cowlitz	WA
Top Shot	Alternative to Herbicides	2023	Mason	WA
School Bus	Alternative to Herbicides	2023	King	WA
Blanchrd FH	Alternative to Herbicides	2023	Stevens	WA
Cleantraxx I*	Herbicide Efficacy	2015	Benton	OR
Cleantraxx II*	Herbicide Efficacy	2017	Benton	OR
Esplanade I*	Herbicide Efficacy	2019	Lewis	WA
Corteva I*	Herbicide Efficacy	2022	Linn	OR
Corteva I*	Herbicide Efficacy	2022	Lincoln	OR
Brownsville*	Planting Techniques	2018	Linn	OR
Senecio I*	Vegetation Competitiveness	2019	Linn	OR
Senecio II*	Vegetation Competitiveness	2019	Lane	OR
Senecio III*	Vegetation Competitiveness	2019	Lincoln	OR



CoSInE

Competition & Site Interactions Experiment

Introduction

- Forest Vegetation Management (VM) is one of the most important reforestation tools in the PNW.
- Crop-tree growth responses to VM treatments are site-specific and often depend on:
  - Site conditions.
  - Early-seral vegetation community.
  - Crop-tree physiology.
- The main objective of this study is to develop a mechanistic understanding of VM treatments effects on Douglas-fir (DF) and western hemlock (WH) seedling growth and survival across a range of site conditions in order to develop a decision support system.

Objectives

Determine the effect of site conditions and VM regimes on:

- Competing vegetation abundance, and composition.
- Soil water availability.
- Soil nutrient availability.
- Seedling growth, survival, biomass development, and water stress status.

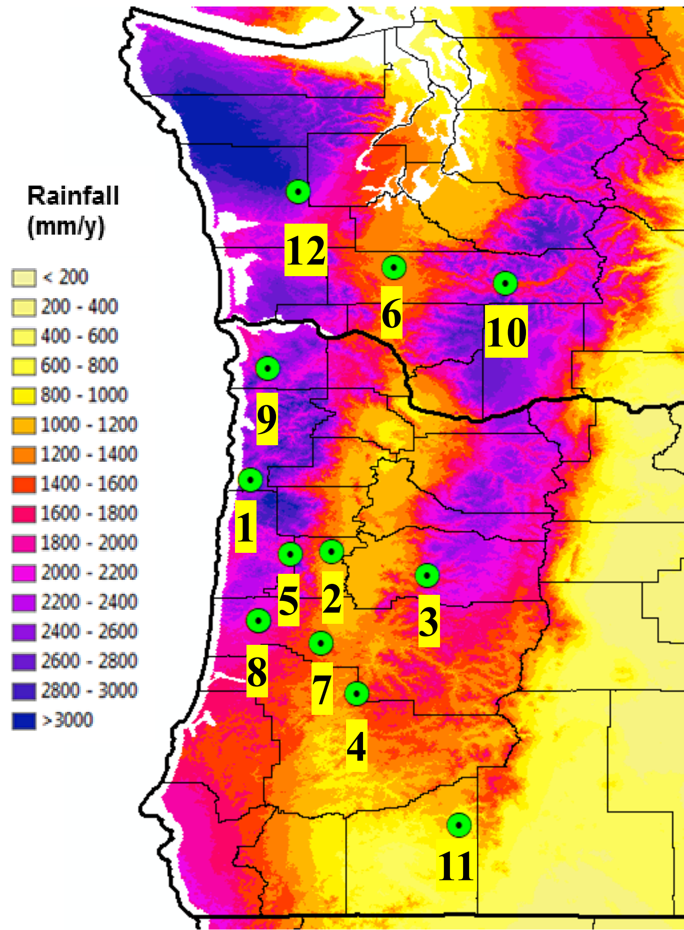
Conduct an integrated analysis and develop a process-based model to simulate seedling/vegetation growth and water use.

Contribute with data for G&Y model (CIPS)

CoSInE Study Objectives

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 Type	Fall site Preparation	Spring Release GS1	Spring Release GS2
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



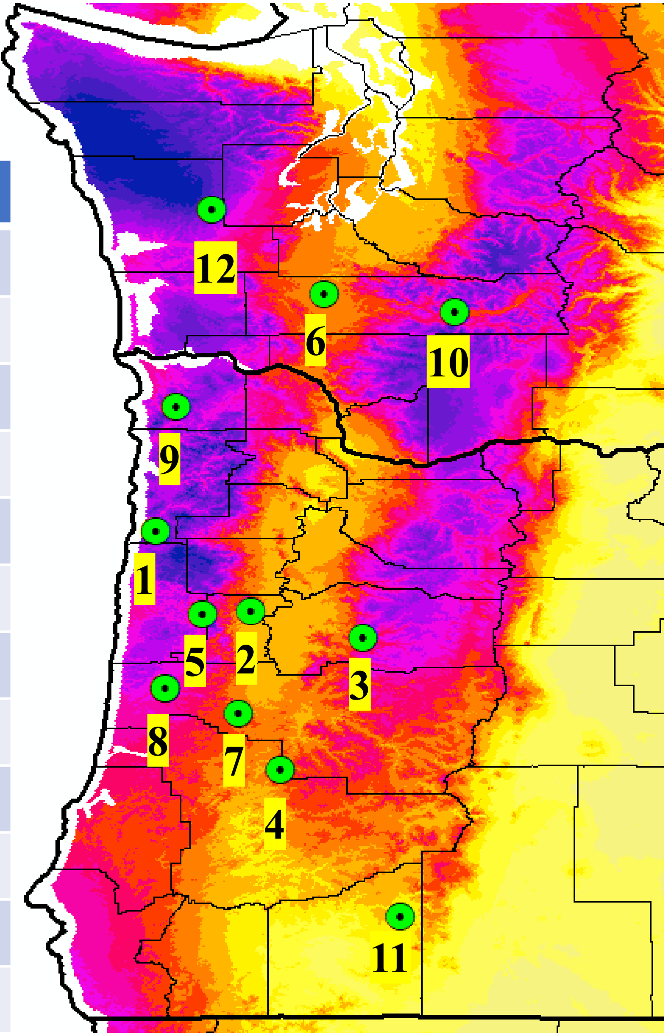
CoSInE Methods

Vegetation Management Research Cooperative
VMRC

CoSInE Site Locations

9 sites DF
3 sites WH

Study ID	Site	Site #	Current Landowner	County	State	Planting Year	Species	Soil Texture
CO101	Bulgogi	1	Weyerhaeuser	Tillamook	OR	2017	WH	Silty Loam
CO201	Mc-Dunn	2	Oregon State University	Benton	OR	2017	DF	Silty Clay Loam
CO202	Boss Hog	3	Cascade Timber Consulting	Linn	OR	2017	DF	Silty Clay Loam
CO203	Burntwoods	4	Starker Forests, Inc.	Lincoln	OR	2018	DF	Silty Clay Loam
CO102	Whipple Hill	5	Lone Rock Timber Co.	Douglas	OR	2018	DF	Silty Loam
CO204	Mountain Sun	6	Rayonier	Lewis	WA	2019	DF	Silty Clay Loam
CO205	7B Pieces	7	Roseburg Forest Products	Lane	OR	2019	DF	Silty Clay Loam
CO103 CO206	River Ranch	8	Roseburg Forest Products	Lane	OR	2020	DF+WH	Silty Clay Loam
CO207	Camp 18	9	GreenWood Resources	Clatsop	OR	2020	WH	Gravelly Loam
CO208	Bull Down	10	Port Blakely	Lewis	WA	2021	DF	Cindery Sandy Loam
CO209	Exhibit E	11	Silver Butte Timber Co.	Cowlitz	OR	2022	DF	Gravelly Loam
CO210	Matlock	12	Green Diamond	Grays Harbors	WA	2023	DF	



Oregon State University

Vegetation Management Research Cooperative

VMRC

Vegetation Management Effects on Early Seral Vegetation Abundance, Species Richness and Diversity

Study Objectives

- Analyze effects of vegetation management treatments on early seral vegetation
- i) abundance
- ii) species richness
- iii) diversity

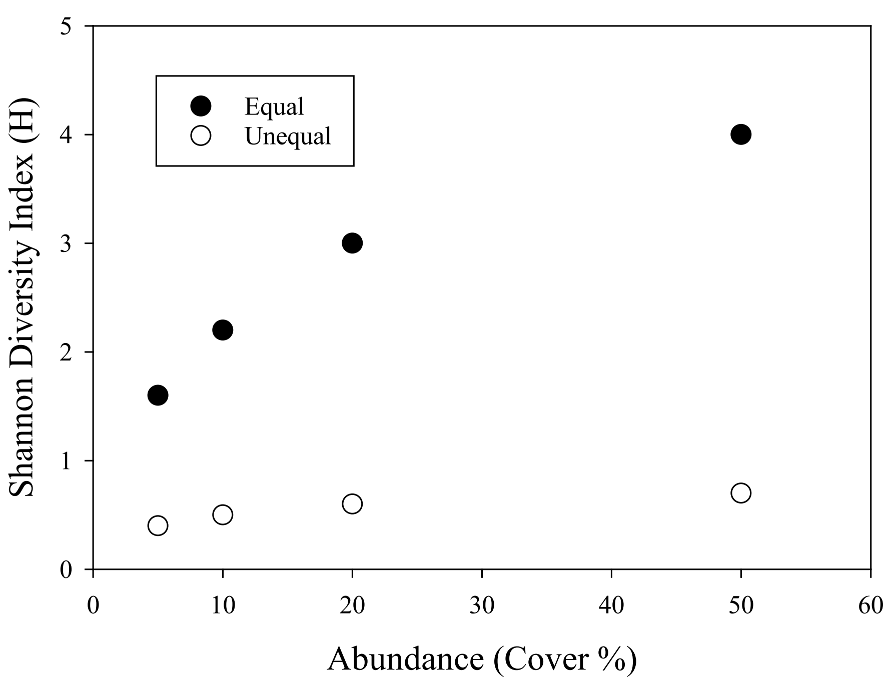
- Estimate Shannon Diversity Index.

- Use CoSInE study sites.

Methods

Estimate Early Seral Vegetation Diversity using Shannon Diversity Index (H)

- Provide more information about community composition than simply species richness.
- Take in account the relative abundances of different species.
- Accounts for both abundance and evenness of the species present.



Two communities with similar abundance (cover)

Equal Distribution: Each species has similar abundance (cover)

Unequal Distribution: One species has 90% of abundance (cover) and the remaining are distributed evenly

VMRC **CoSInE** Study

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 Preparation**	**Spring Release Growing Season 1**	**Spring Release 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 Site Locations

11 sites

8 treatments (plots) per site

No replications (1 block per site)

Study ID	Site	Site #	Current Landowner	County	State	Planting Year	Species	Soil Texture
CO101	Bulgogi	1	Weyerhaeuser	Tillamook	OR	2017	WH	Silty Loam
CO201	Mc-Dunn	2	Oregon State University	Benton	OR	2017	DF	Silty Clay Loam
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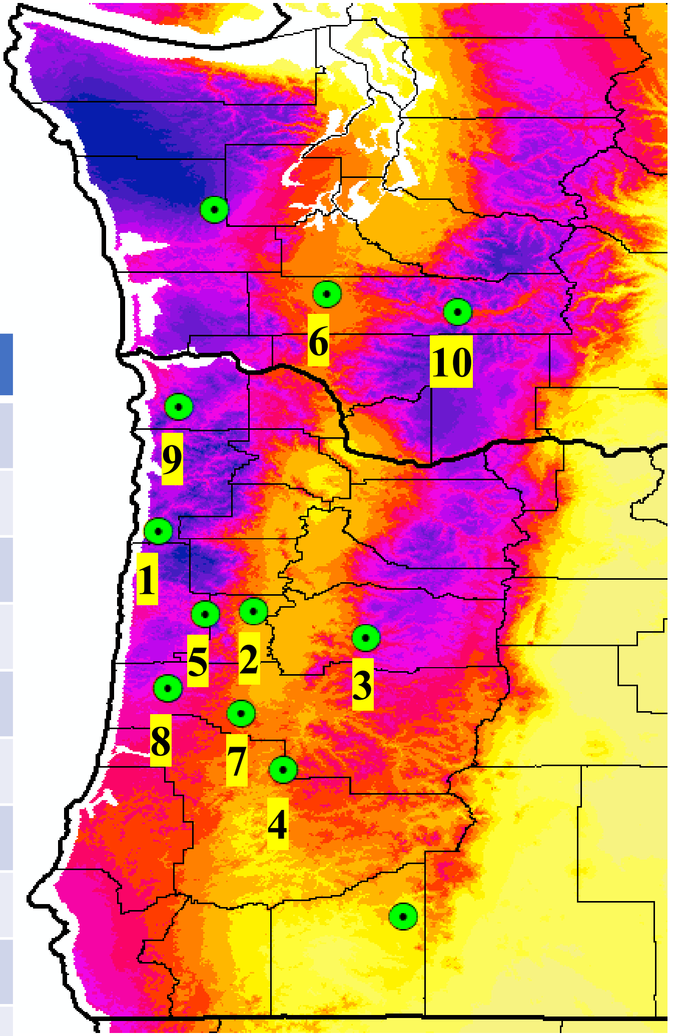
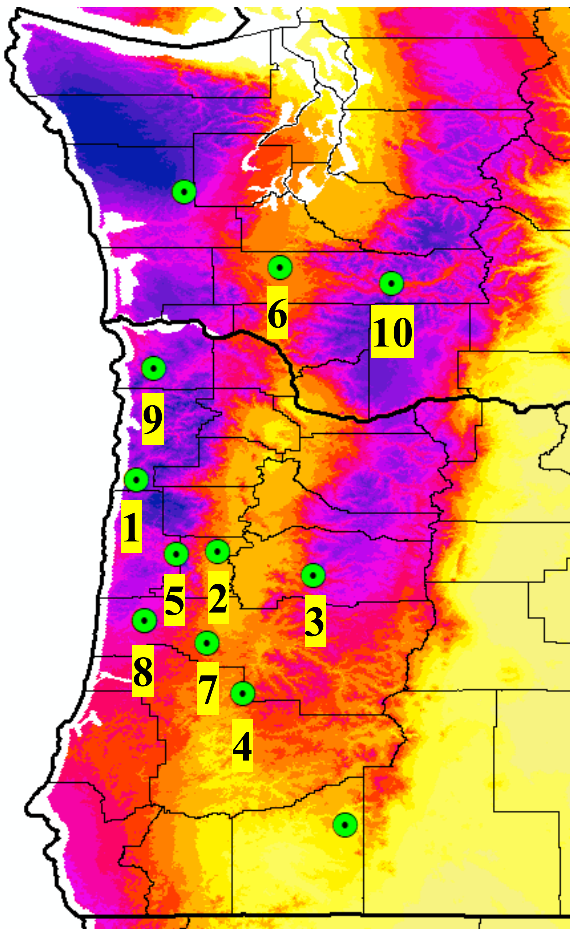
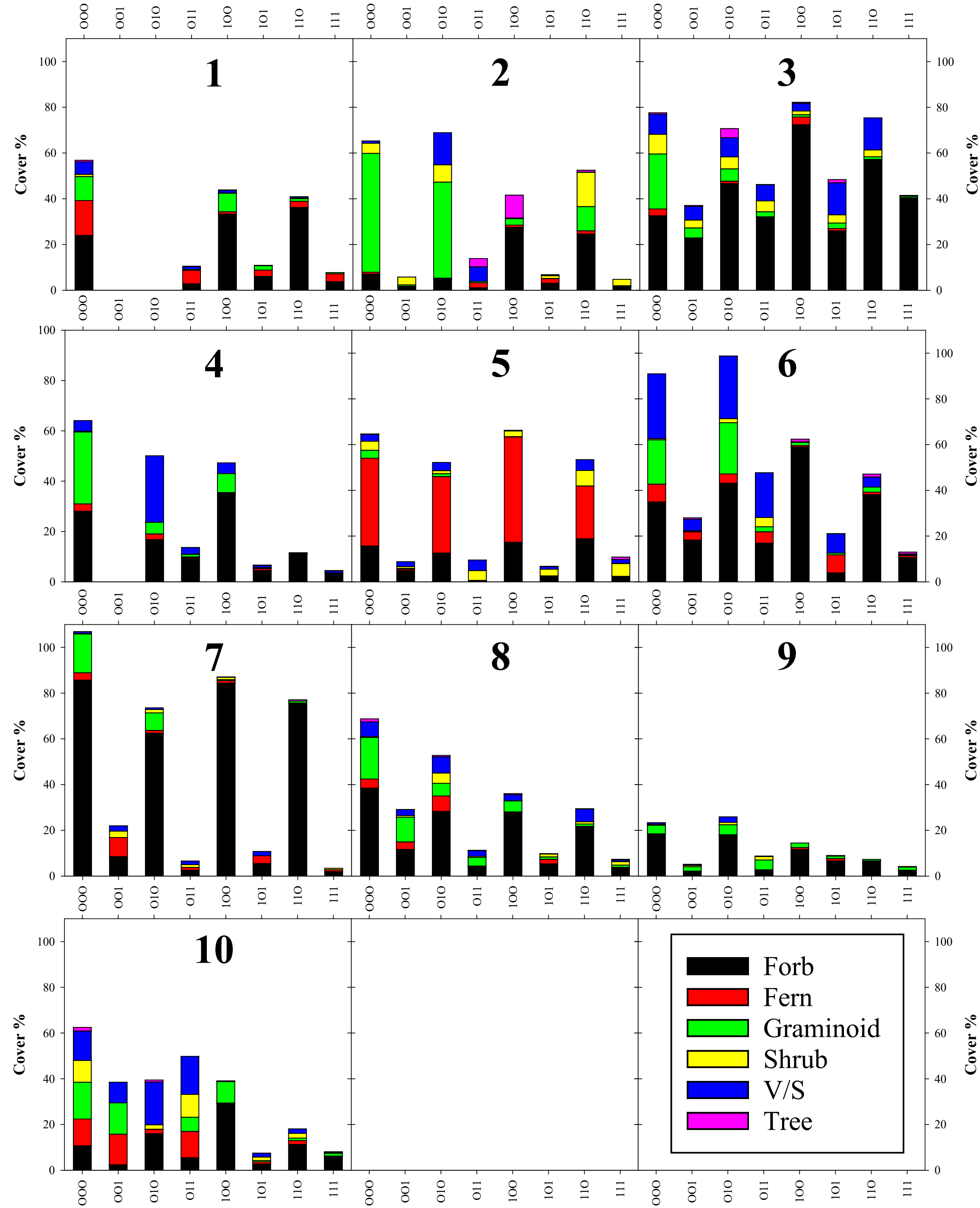


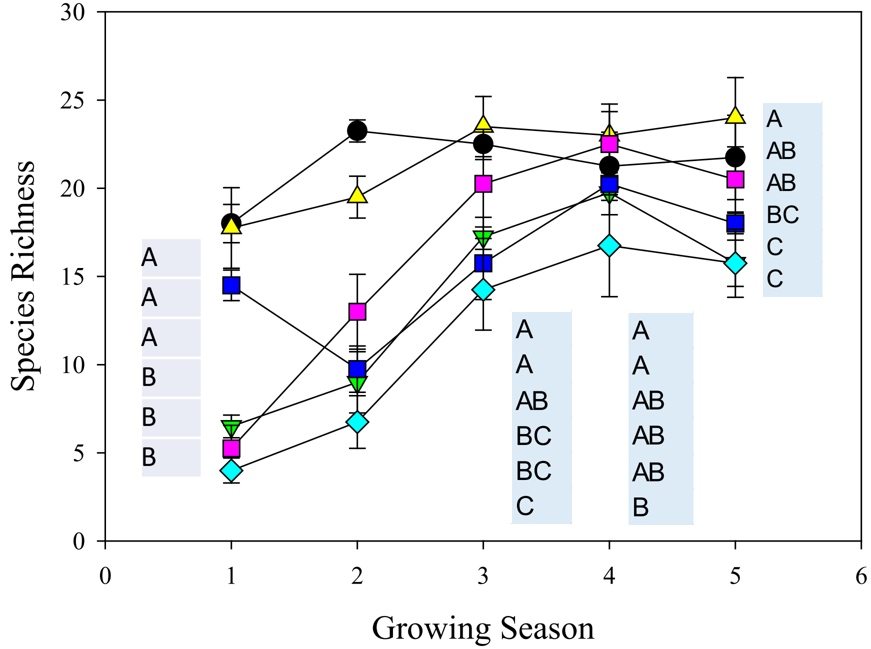
Vegetation Cover %
Growing Season 2
10 CoSInE Sites

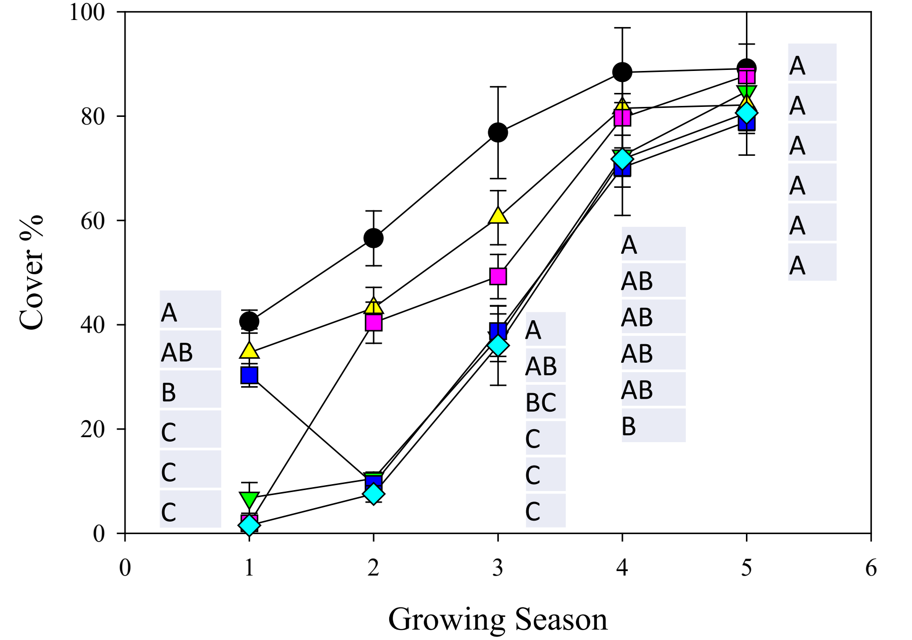


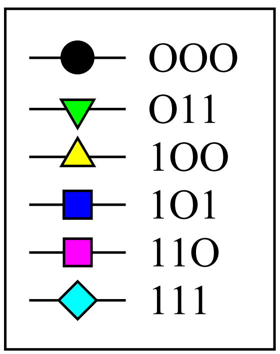


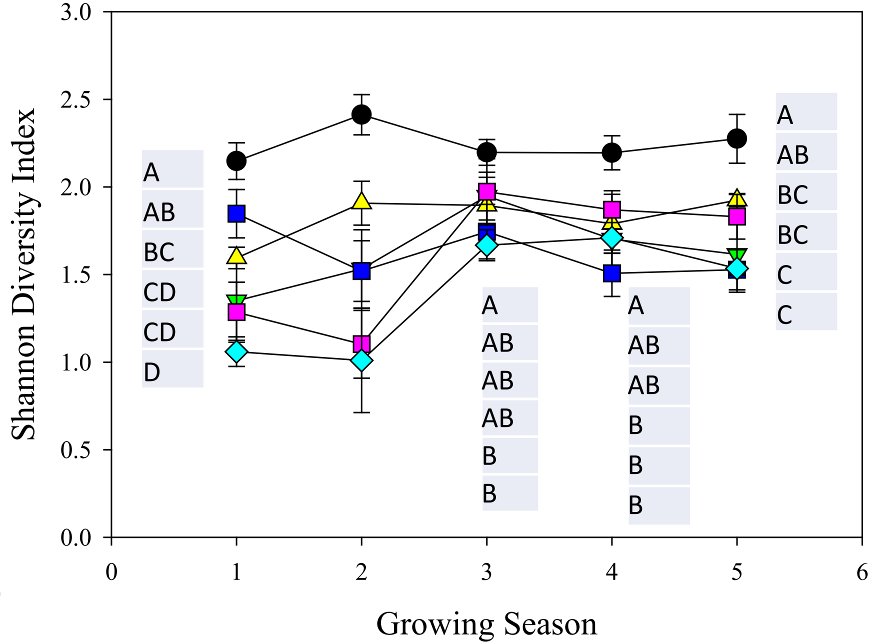
Results

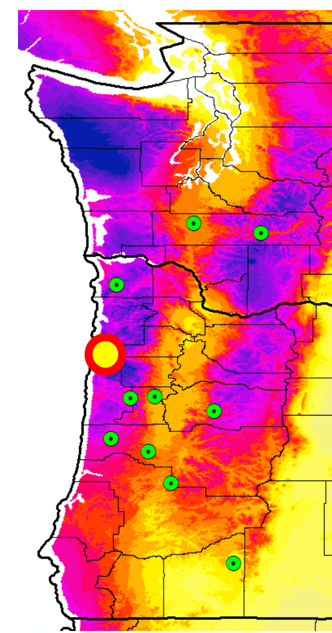
CO101 (Wet)







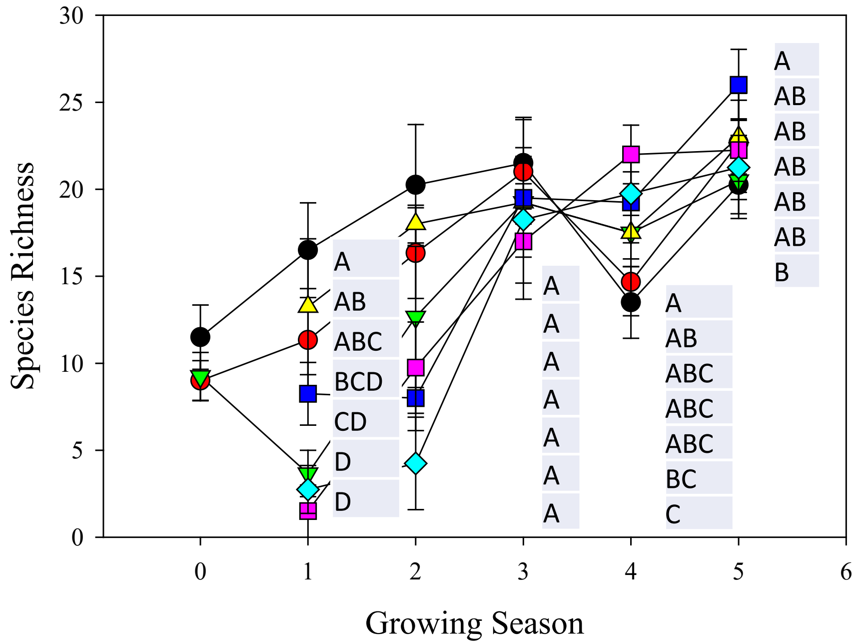


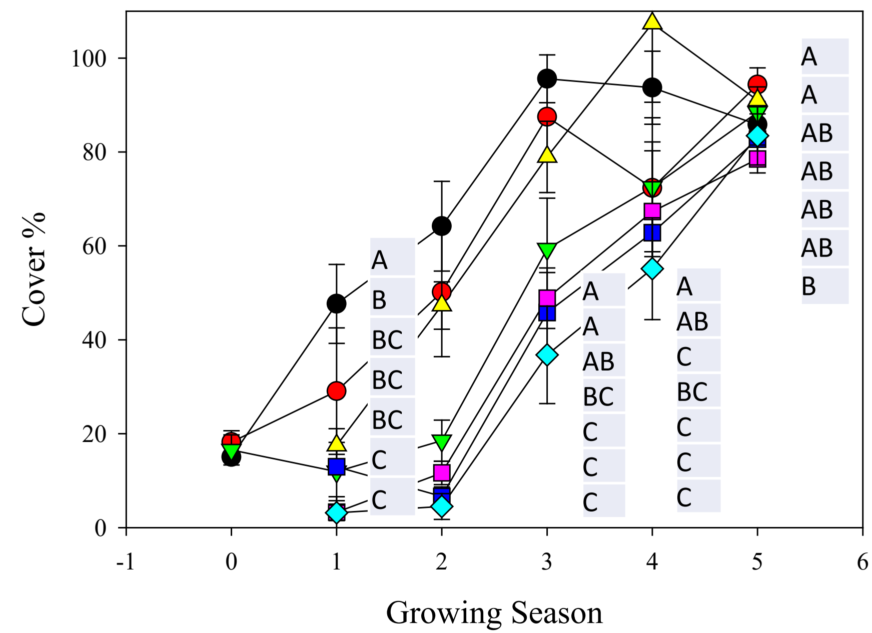


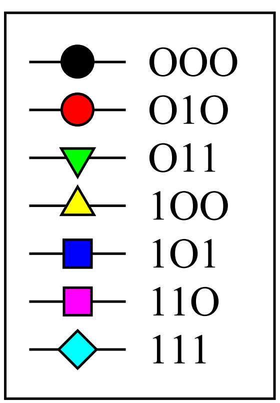
All Species
(Native and Introduced)

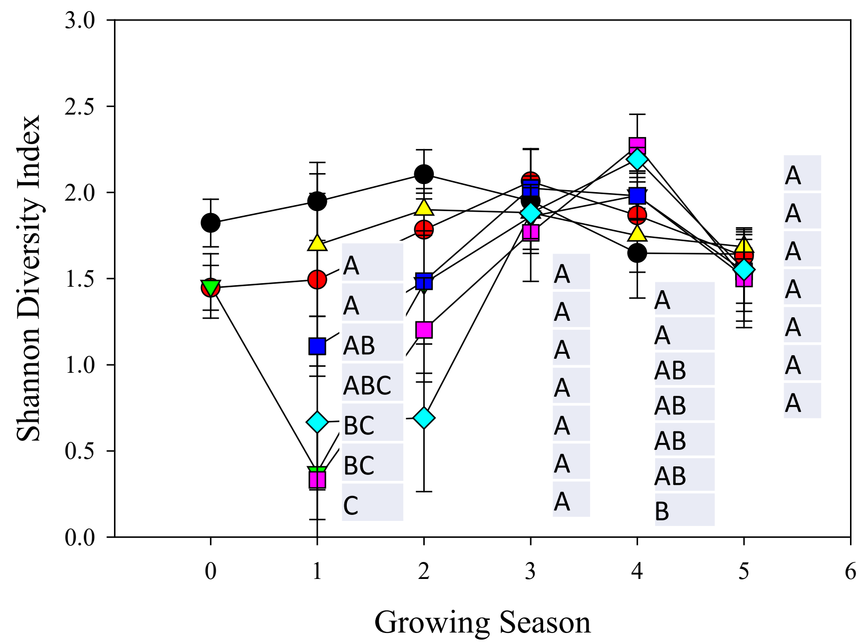
Results

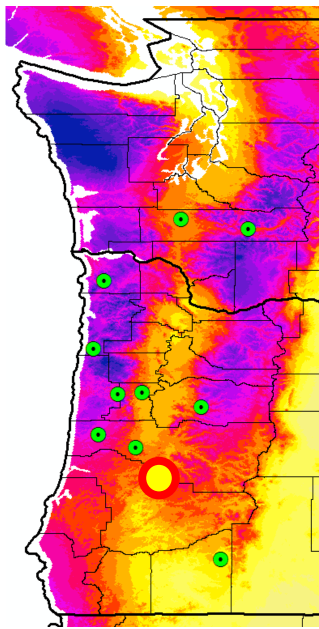
CO102 (Dry)











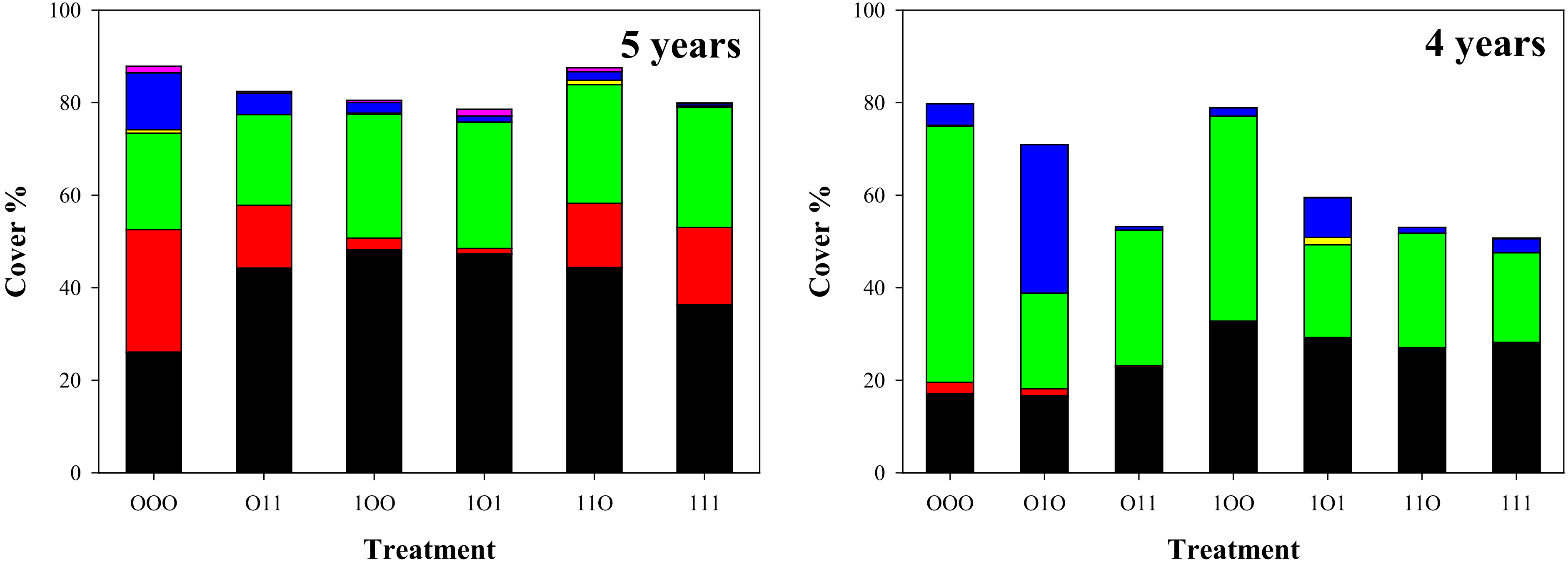
All Species
(Native and Introduced)

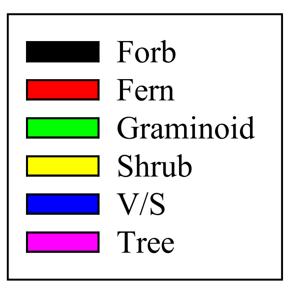
Results

Abundance (Cover)

CO101 (Wet)

CO102 (Dry)



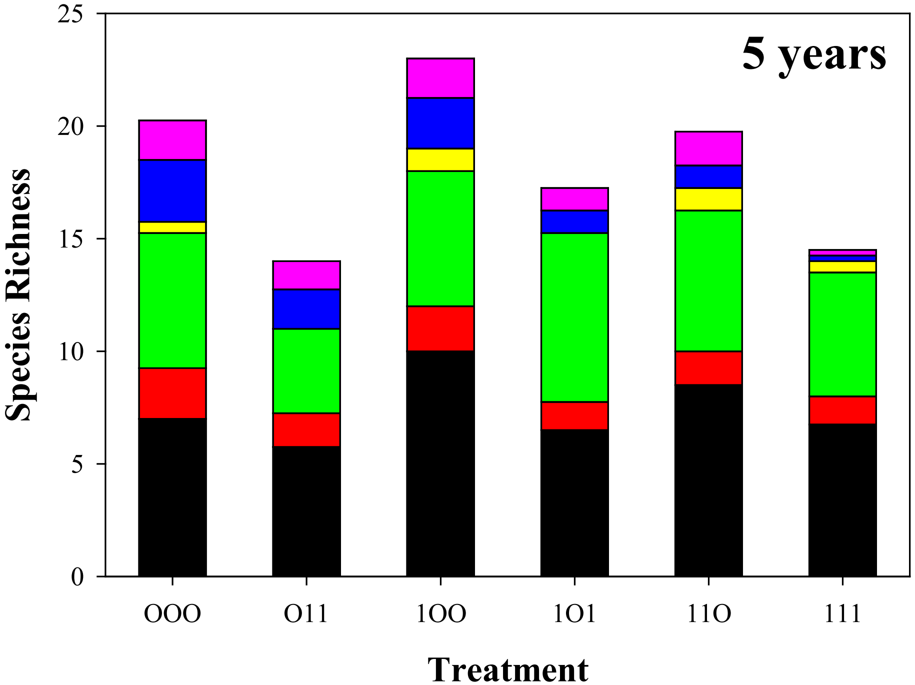


All Species
(Native and Introduced)

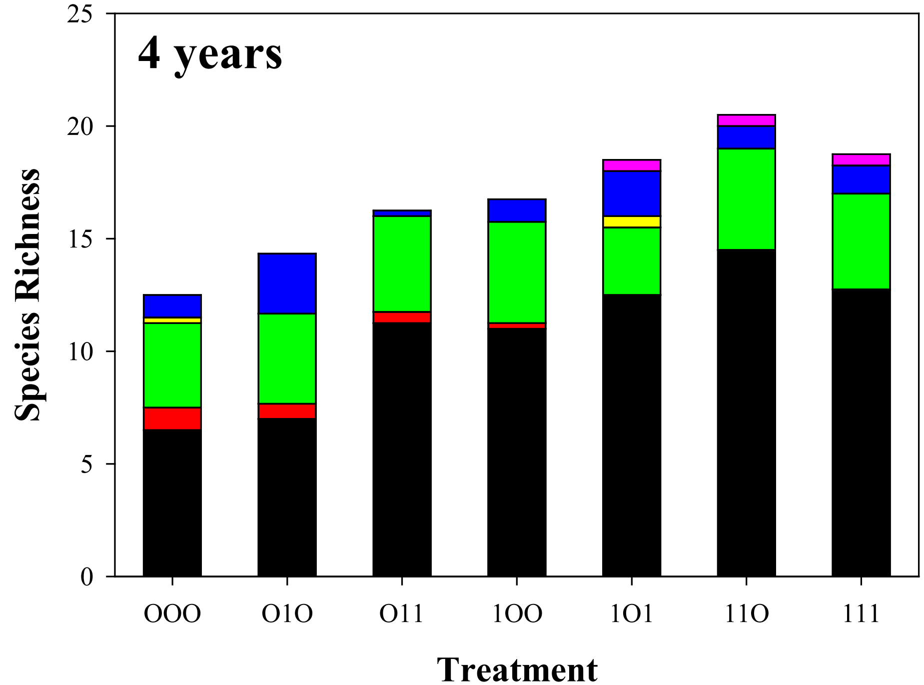
Results

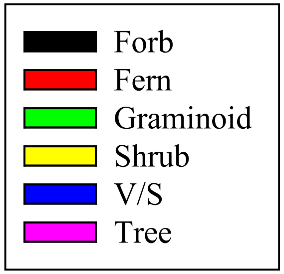
Species Richness

CO101 (Wet)



CO102 (Dry)

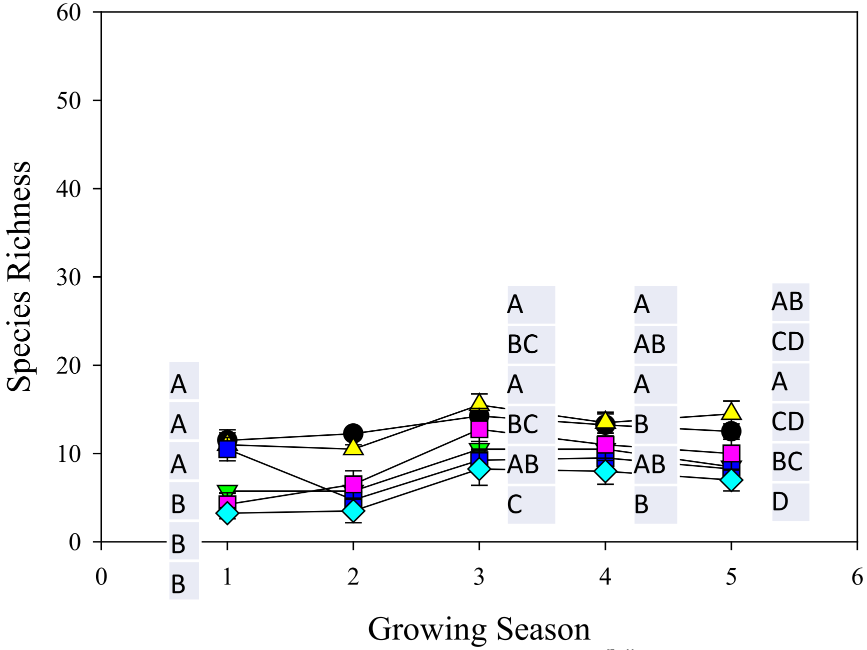


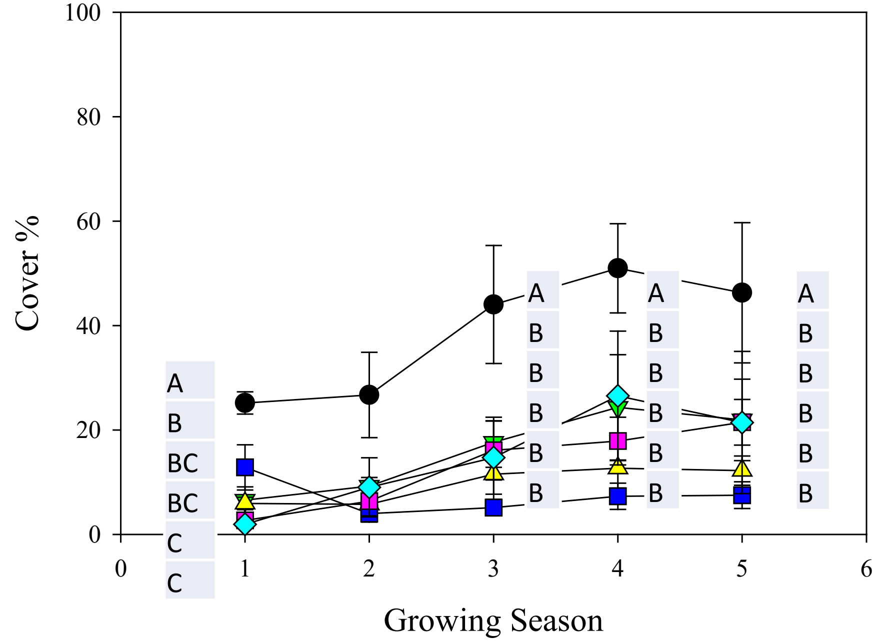


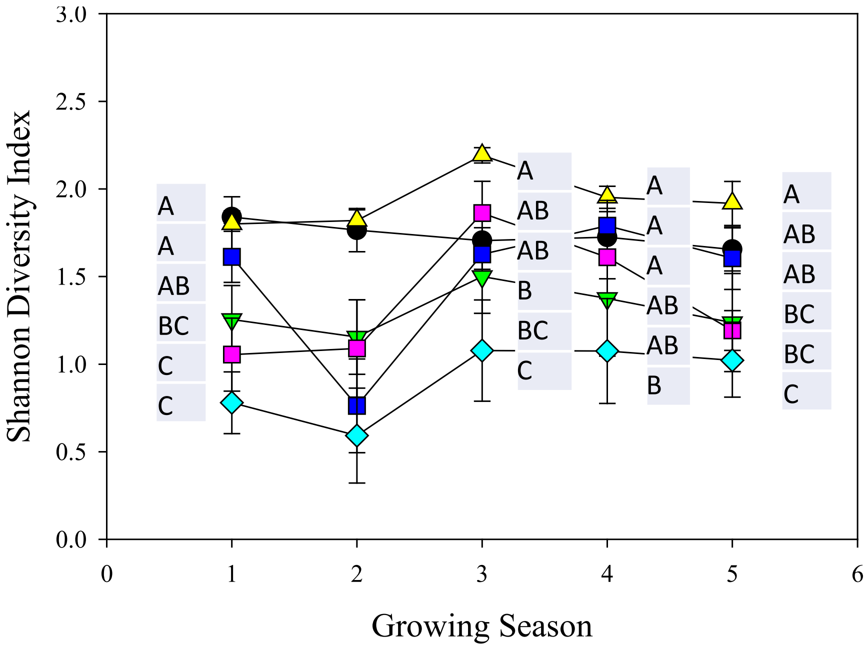
All Species
(Native and Introduced)

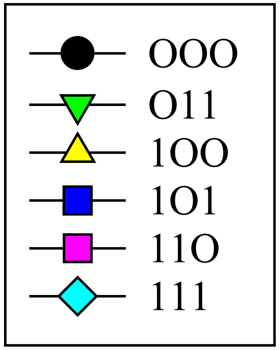
Results

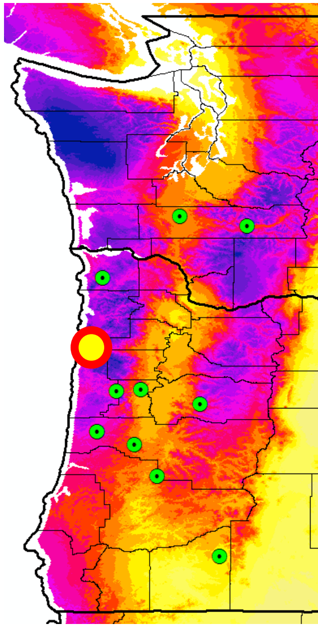
CO101 (Wet)







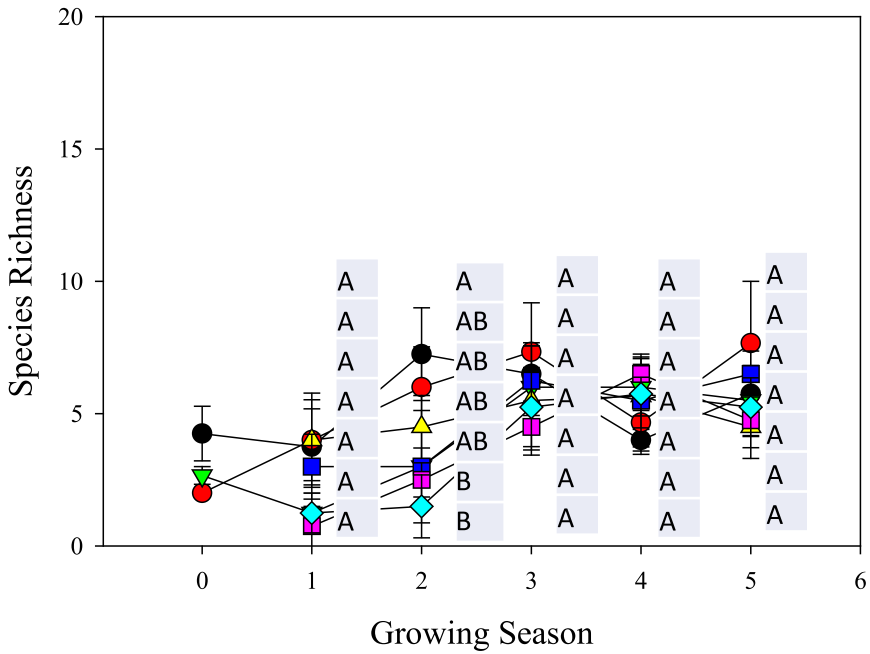


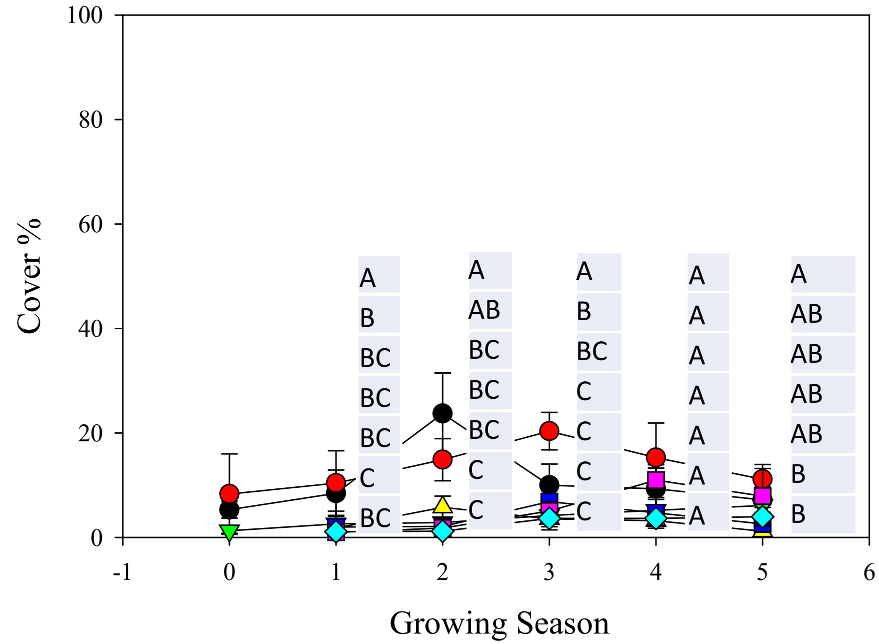


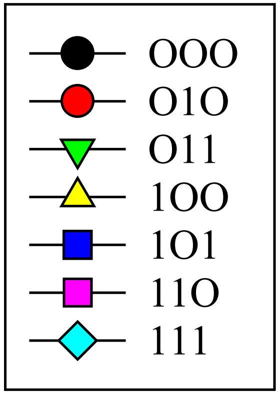
Only Native Species

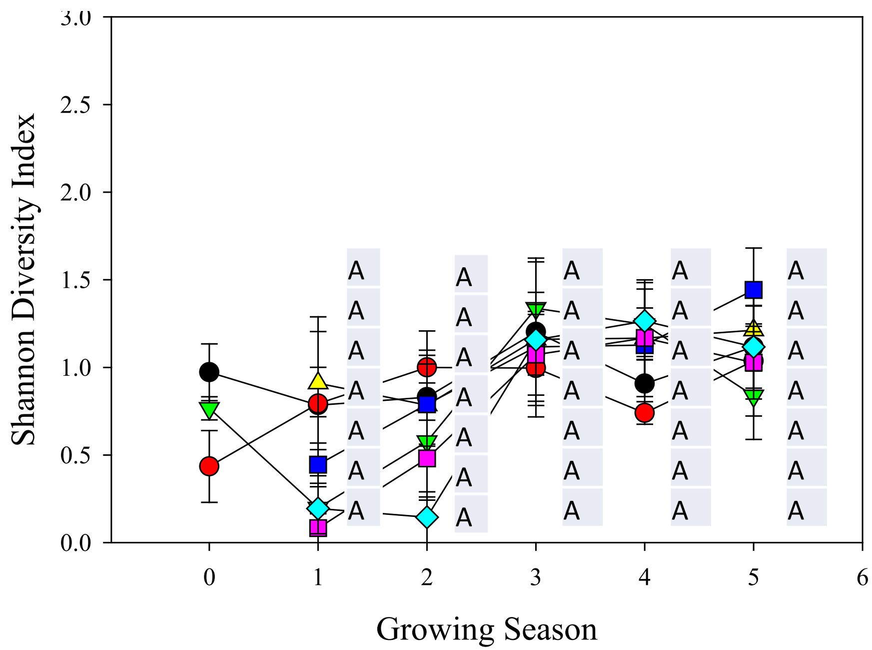
Results

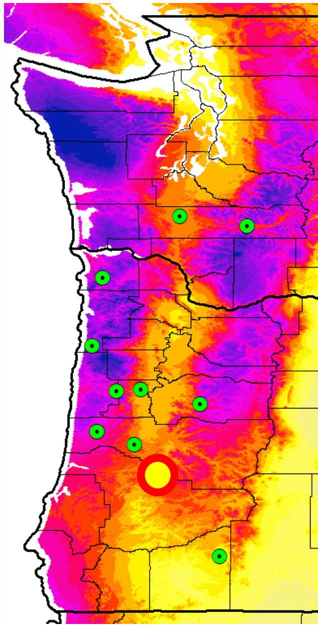
CO102 (Dry)











Only Native Species

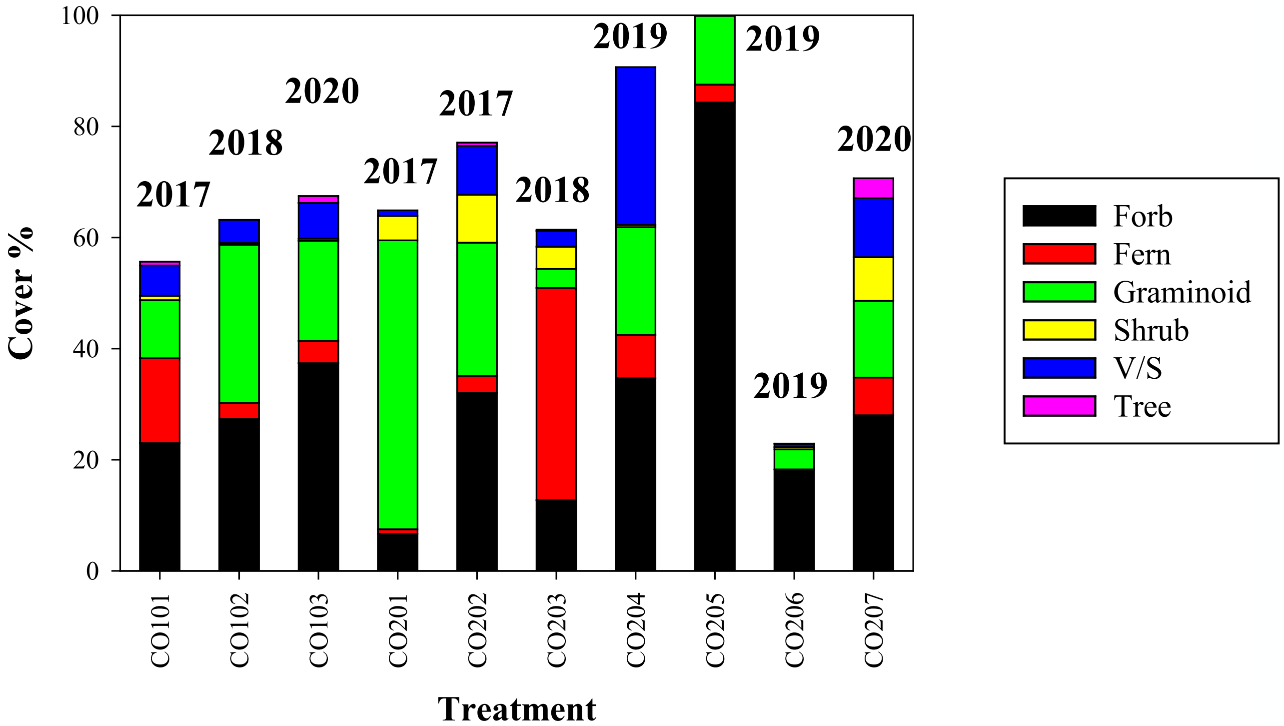
Results

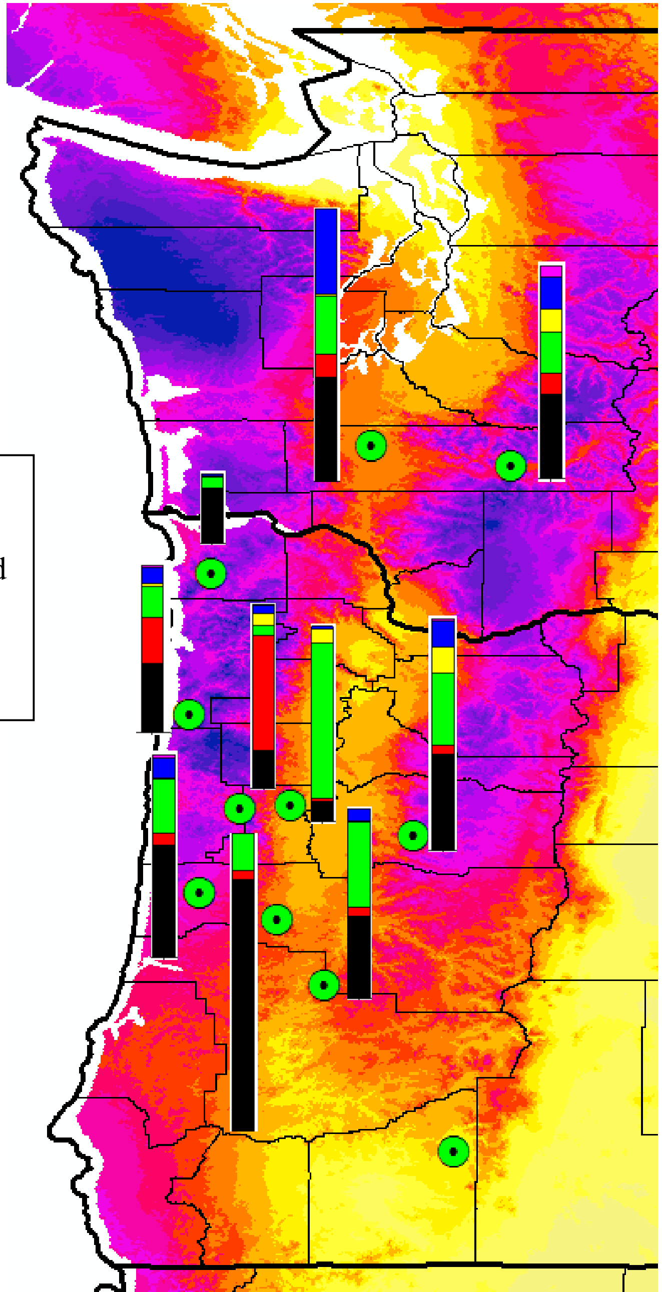
Responses are site-specific

Results

All 10 Sites

At Growing Season 1
Control Plot (OOO)



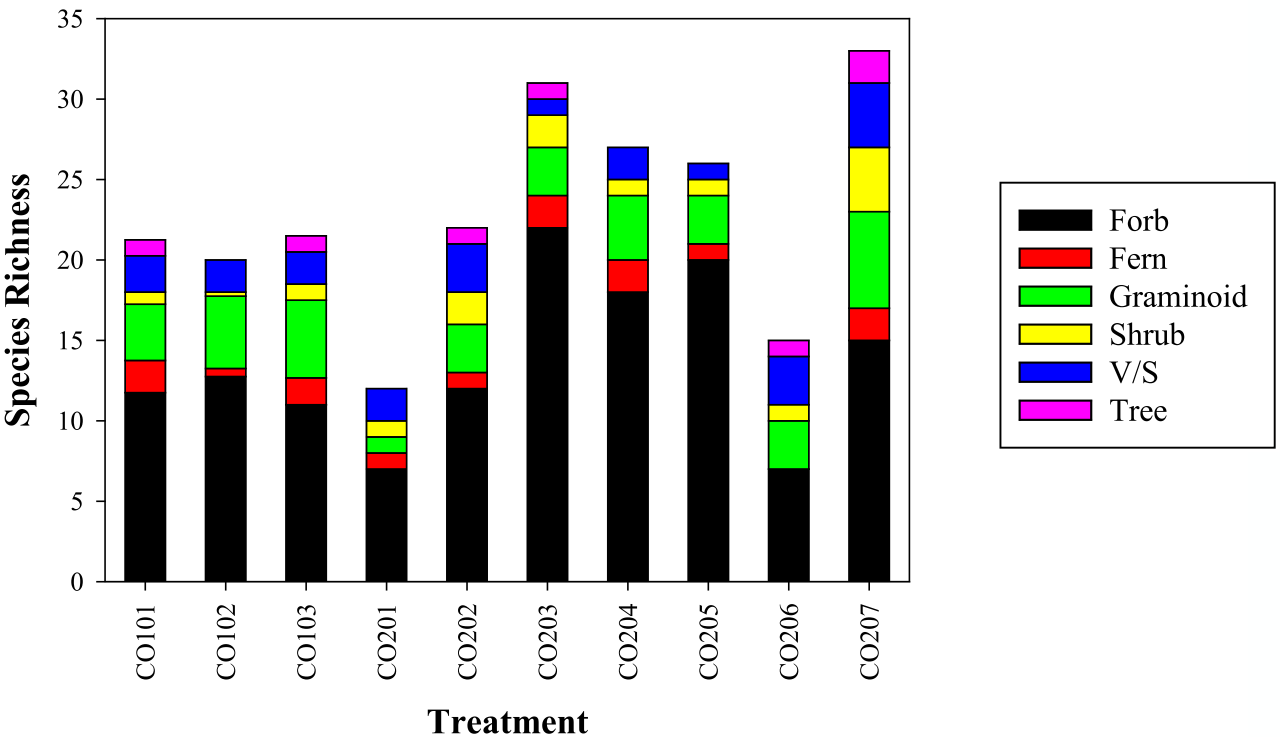


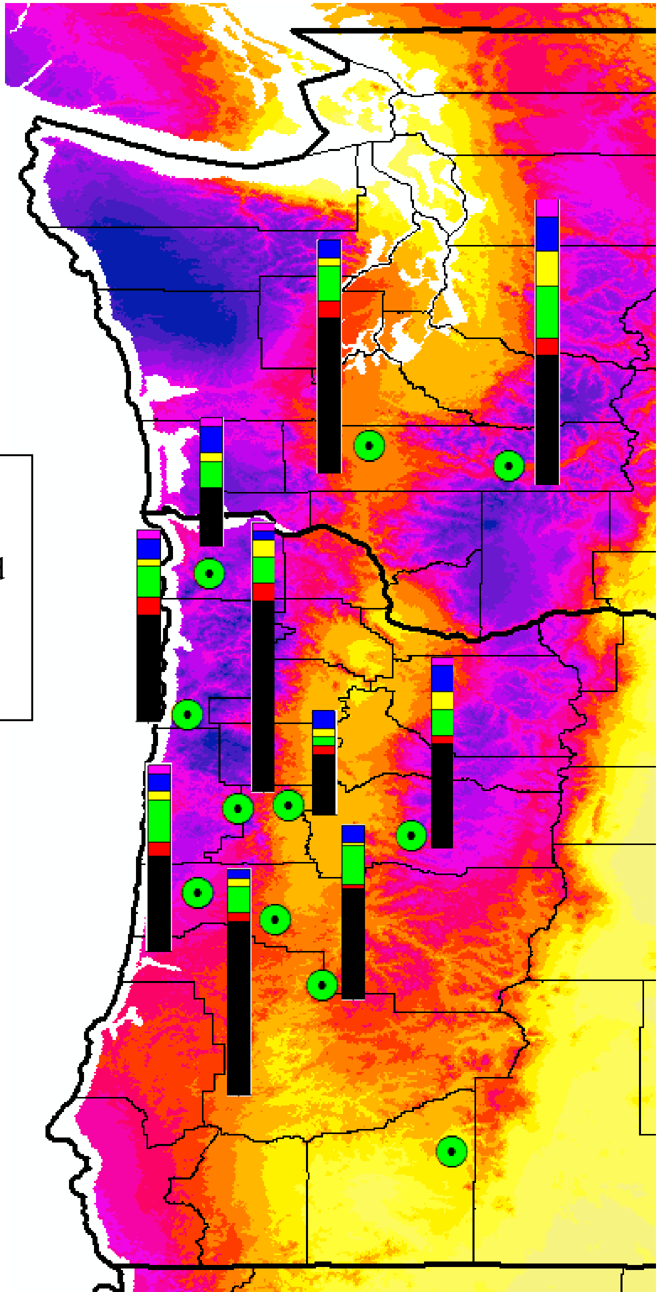
All Species
(Native and Introduced)

Results

All 10 Sites

At Growing Season 1
Control Plot (OOO)

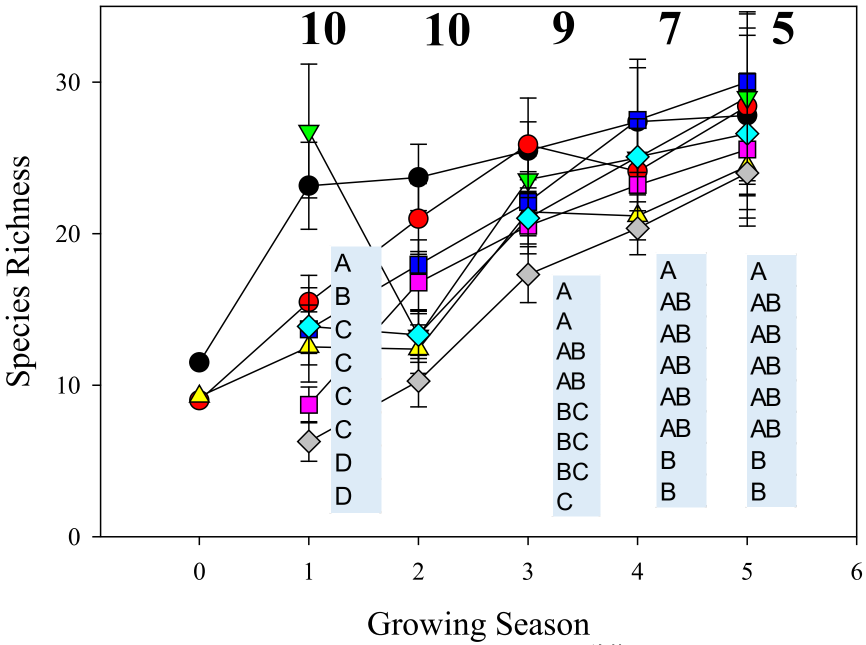


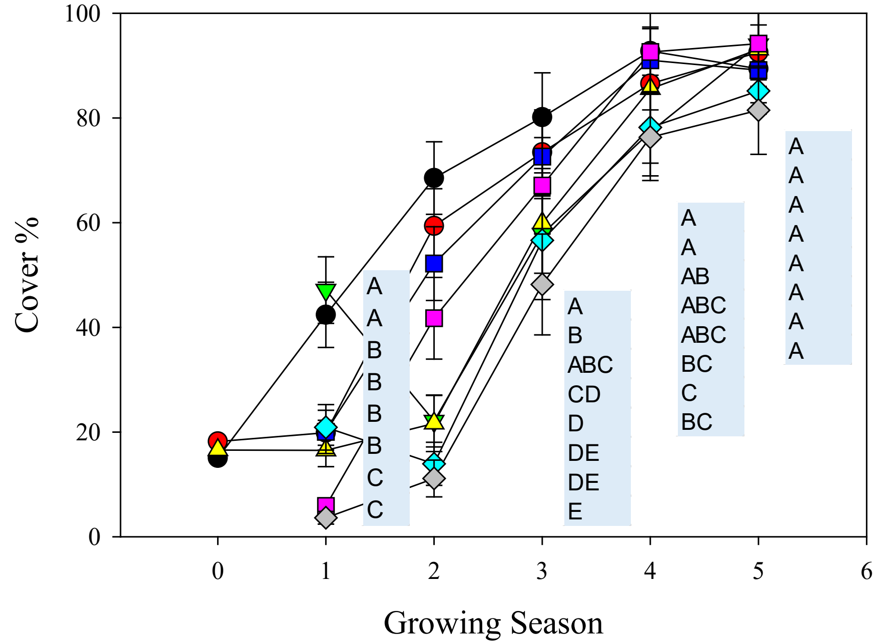


All Species
(Native and Introduced)

Results

All 10 Sites





All Species
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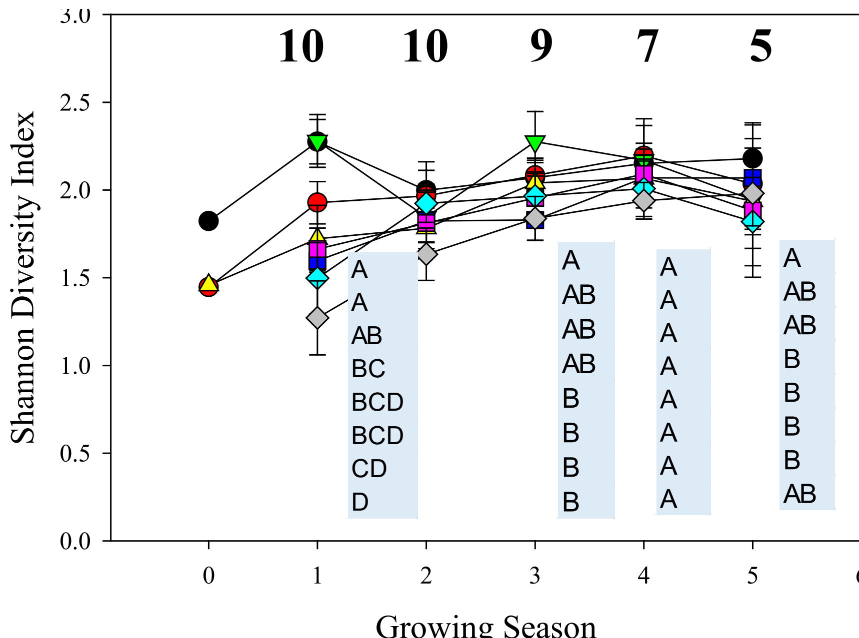
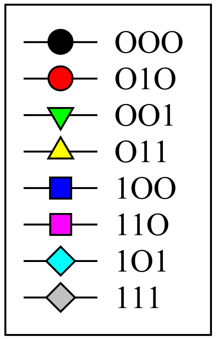
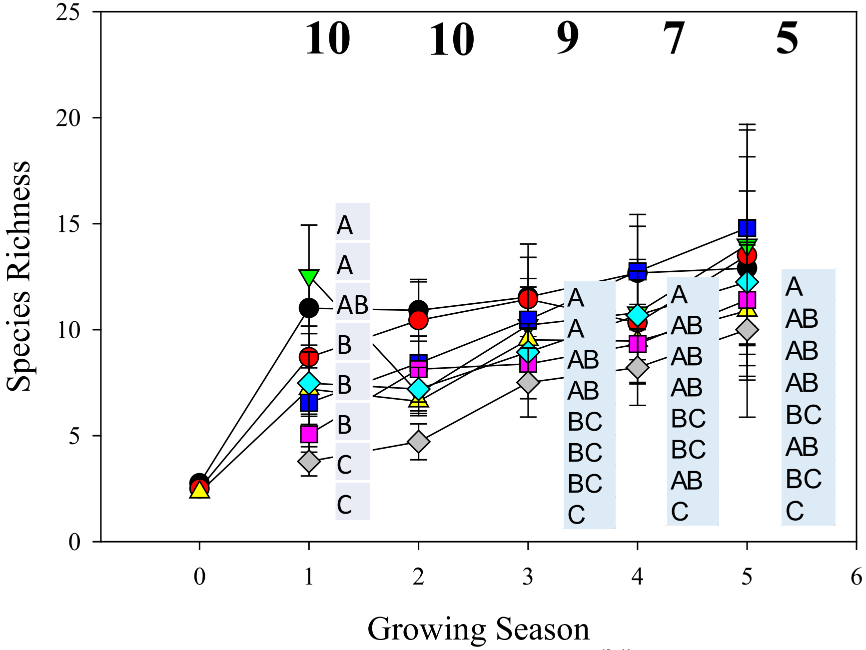
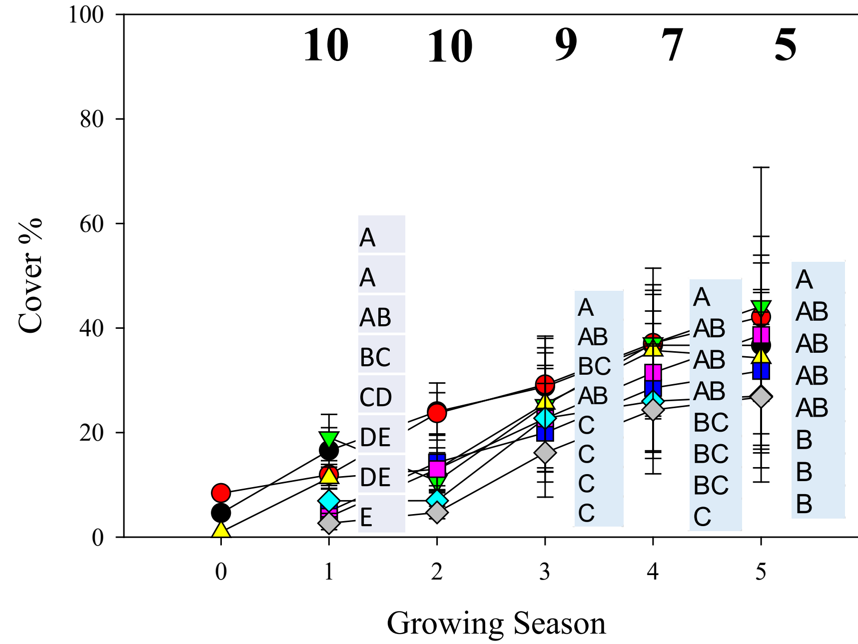




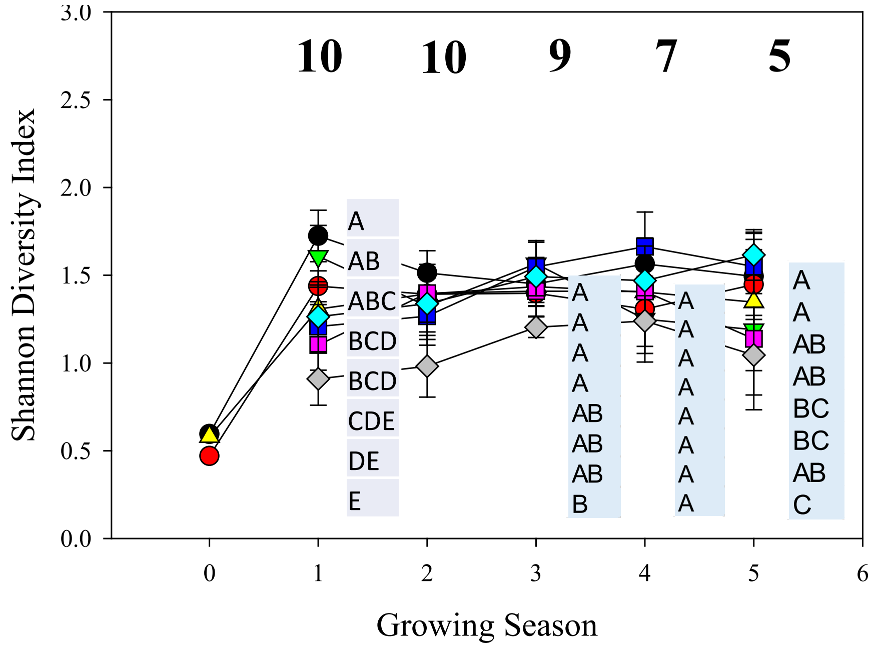
Results

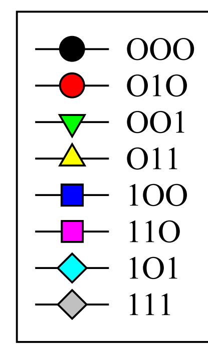
All 10 Sites





Only Native Species





Conclusions

- Responses are site-specific

- Across all 10 sites at growing season 5:
  - For all Native and Introduced species: No effect of VM treatments on Vegetation Diversity Index (even though there was a reduction in cover).

  - For Native species: All treatments with 1 or 2 herbicide applications showed no difference in Vegetation Diversity Index with control (no action) treatment (only 111 showed reduced Diversity).

Vegetation Management Effects on Biomass and Nitrogen Stock

Rationale

- Most of results of VMRC show effects on seedling growth and/or vegetation abundance and diversity.
- Is widely recognized and demonstrated that early seral vegetation competes for water.
- Little information is available about competition for nutrients.

Study Objectives

- Analyze effects of vegetation management treatments on nutrient concentration (%) and content (kg/ha) on:
  i) Early seral vegetation (by growth habit)
  ii) Crop conifer species planted

  - From planting to age 5 years
  - All Macro and Micro nutrients
  - In this presentation: Only Nitrogen in 2 sties.
- Use CoSInE study sites.

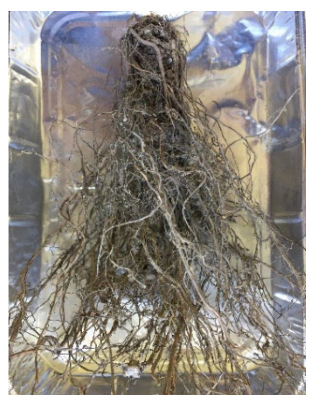
Methods Biomass

Seedlings

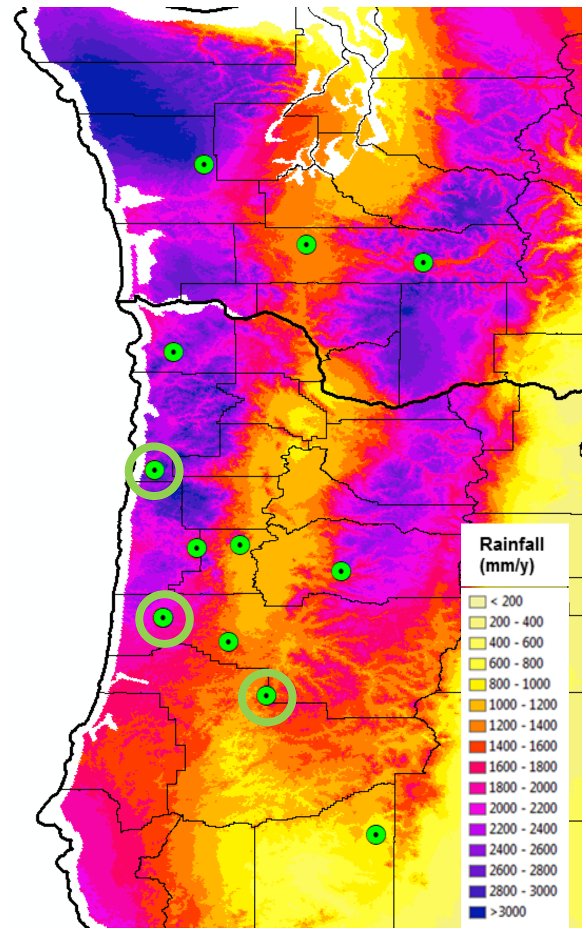
3 sites CO101, CO102, CO102
2 species WH and DF
4 treatments OOO and 111 (also 100 and 011)
3 years 1, 2 and 3
6-8 seedlings x site x spp x trt x year

Foliage

Stem



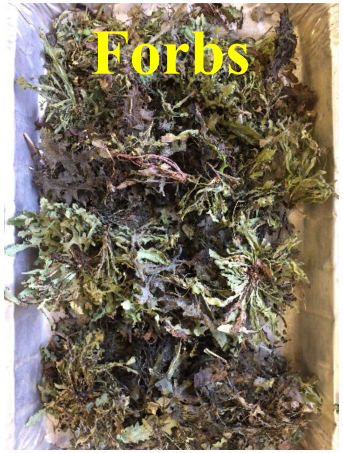
Roots

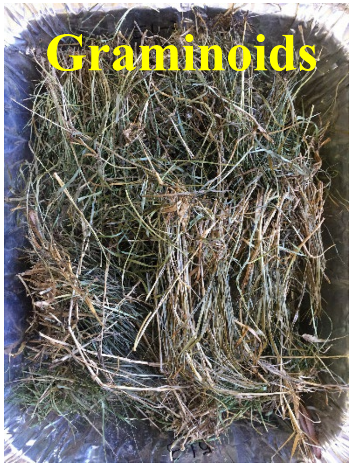


Methods

Biomass

Vegetation





Methods

Nutrients

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REPORT NUMBER: 23426 **CLIENT NO:** 8202

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CORVALLIS OR 97331

GROWER: OREGON STATE UNIVERSITY

SUBMITTED BY: CARLOS GONZALEZ

DATE OF REPORT: 06/22/22 **PAGE:** 1

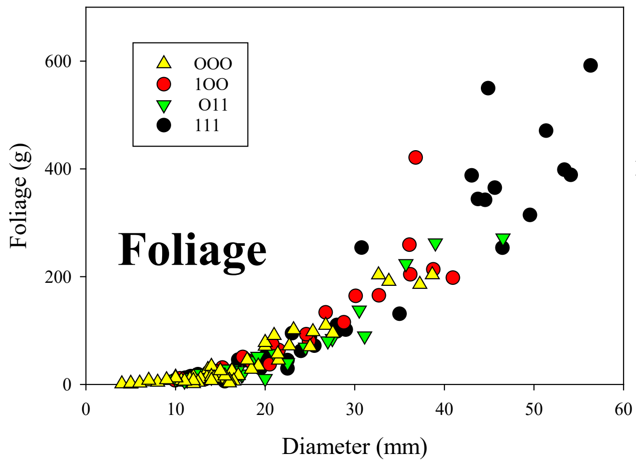
PLANT ANALYSIS REPORT

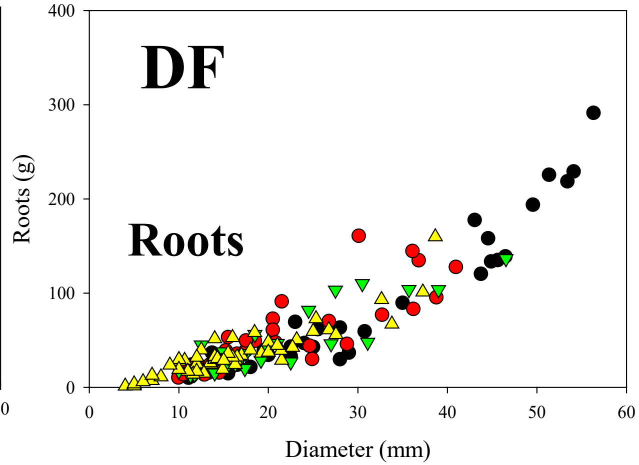
SAMPLE ID	REPORT OF ANALYSIS IN PERCENT								REPORT OF ANALYSIS IN PARTS PER MILLION								
	Nitrogen N	Sulfur S	Phosphorus P	Potassium K	Magnesium Mg	Calcium Ca	Sodium Na	Chloride Cl	Iron Fe	Aluminum Al	Manganese Mn	Boron B	Copper Cu	Zinc Zn	Nitrate-Nitrogen NO_3-N	Phosphate PO_4-P	Molybdenum Mo
C283	1.09	0.09	0.13	1.88	0.11	0.22	0.02		64	131	107	9	4	44			< 0.5
C284	0.82	0.21	0.17	1.03	0.12	0.22	0.02		96	285	234	10	2	17			< 0.5
C285	0.18	0.08	0.04	0.33	0.10	0.16	< 0.01		3	< 0.5	254	7	1	5			< 0.5
C286	1.37	0.30	0.17	3.10	0.24	1.42	0.11		127	156	62	23	11	31			< 0.5
C287	1.11	0.20	0.20	2.71	0.28	1.09	0.34		128	275	114	26	10	55			< 0.5
C288	0.92	0.15	0.13	1.94	0.20	0.69	0.08		105	189	113	21	9	27			< 0.5
C289	1.05	0.12	0.17	1.48	0.27	0.40	0.02		52	625	100	20	6	22			< 0.5
C290	1.24	0.16	0.17	1.79	0.30	0.38	0.02		63	881	102	25	8	47			< 0.5
C291	0.91	0.14	0.10	1.62	0.26	0.35	0.03		42	738	55	20	5	49			< 0.5

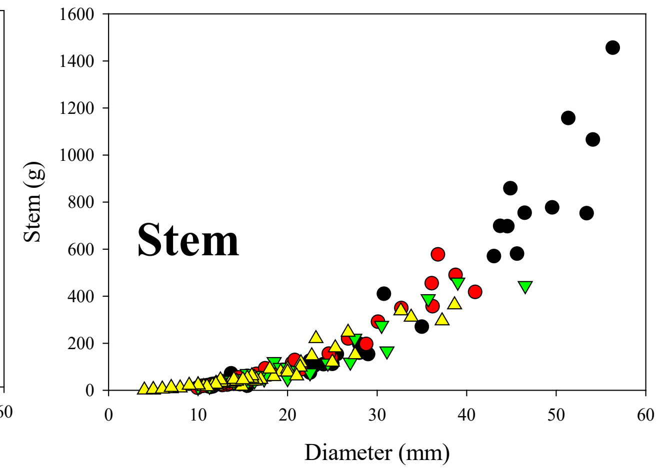
102 samples WH (36 foliage, 36 stem, 36 roots)
123 samples DF (41 foliage, 41 stem, 41 roots)
99 samples vegetation (21 Fern, 24 Forb, 23 Graminoid, 22 V/S, 9 Shrub)

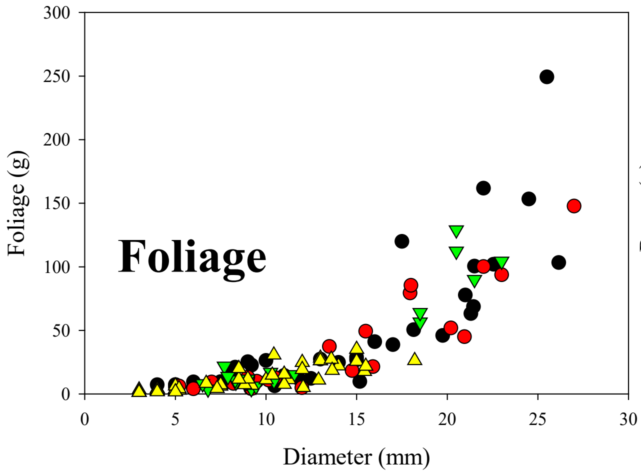
Results

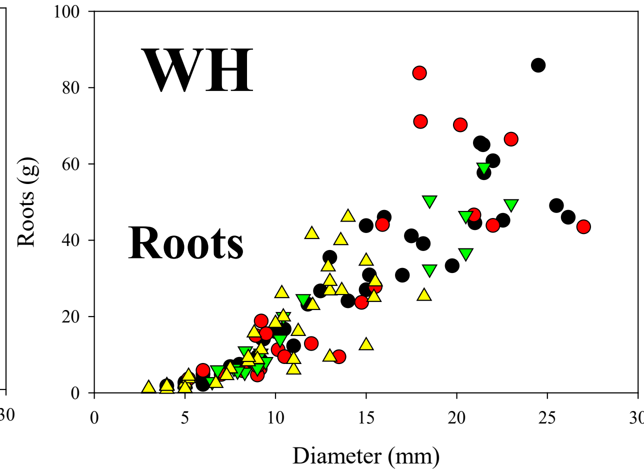
Seedling Biomass

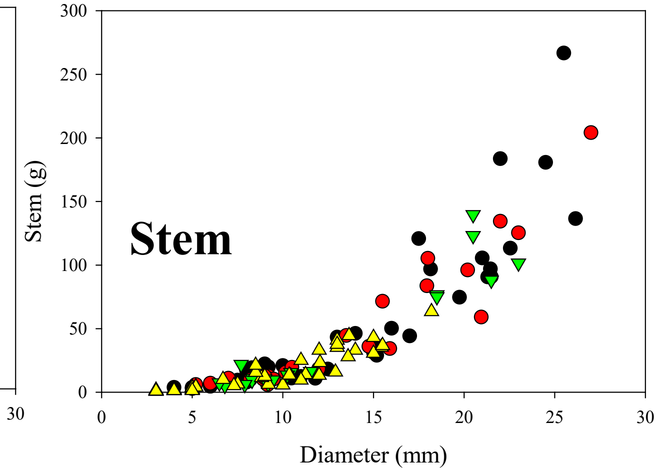












FOLIAGE Spp=DF	model	= a*(DC**b)*(HT**c)*(Age**d) ;

ROOT Spp=DF	model	= a*(DC**b)*(HT**c);

STEM Spp=DF	model	= a*(DC**b)*(HT**c)*(Age**d) ;

FOLIAGE Spp=WH	model	= a*(DC**b)*(Age**d)

ROOT Spp=WH	model	= a*(DC**b)*(HT**c);

STEM Spp=WH	model	= a*(DC**b)*(HT**c)*(Age**d) ;

Results

Vegetation Biomass

forests

MDPI

Article

Ground Cover—Biomass Functions for Early-Seral Vegetation

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Abstract: Vegetation biomass is commonly measured through destructive sampling, but this method is time-consuming and is not applicable for certain studies. Therefore, it is necessary to find reliable methods to estimate vegetation biomass indirectly. Quantification of early-seral vegetation biomass in reforested stands in the United States Pacific Northwest (PNW) is important as competition between the vegetation community and planted conifer seedlings can have important consequences on seedling performance. The goal of this study was to develop models to indirectly estimate early-seral vegetation biomass using vegetation cover, height, or a combination of the two for different growth habits (ferns, forbs, graminoids, brambles, and shrubs) and environments (wet and dry) in reforested timber stands in Western Oregon, USA. Six different linear and non-linear regression models were tested using cover or the product of cover and height as the only predicting variable, and two additional models tested the use of cover and height as independent variables. The models were developed for six different growth habits and two different environments. Generalized models tested the combination of all growth habits (total) and sites (pooled data set). Power models were used to estimate early-seral vegetation biomass for most of the growth habits, at both sites, and for the pooled data set. Furthermore, when power models were preferred, most of the growth habits used vegetation cover and height separately as predicting variables. Selecting generalized models for predicting early-seral vegetation biomass across different growth habits and environments is a good option and does not involve an important trade-off by losing accuracy and/or precision. The presented models offer an efficient and non-destructive method for foresters and scientists to estimate vegetation biomass from simple field or aerial measurement of cover and height. Depending on the objectives and availability of input data, users may select which model to apply.

Keywords: allometry; biomass; competing vegetation; cover; early-seral vegetation; reforestation; understory; vegetation abundance

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1. Introduction

The characterization of vegetation community biomass has been widely studied for decades due to its importance in applied ecology. Vegetation biomass has been used to characterize biomes and ecosystems [1], to predict fire behavior [2], to estimate carbon stocks [3], as an indicator of ecological functioning and site productivity [4,5], for sustainable energy generation [6], for wildlife foraging supply [7,8], and as a surrogate of species richness and composition of plant communities, among other uses [9,10]. The most common method of measuring vegetation biomass in the field is through destructive sampling, but this method is time-consuming and requires multiple repetitions to accurately represent the morphological diversity within a species or a vegetation community. Destructive sampling is also not applicable for permanent plot studies, susceptible environments, or protected areas. Due to this, researchers have sought to estimate vegetation biomass with indirect techniques [10–12].

Current indirect methods of estimating vegetation biomass are oriented to analyze macro-scale patterns and utilize equipment, such as LiDAR [1,3,13,14] or remote-

Table 4. Parameter estimates and fit statistics of the selected functions to estimate biomass from cover and height for each growth habit of early-seral vegetation growing in Western Oregon.

Site	Growth Habit	Model	Parameter	Parameter Estimate	SE	R^2	RMSE	CV
CW	Bracken fern	$= a \cdot Cover^b \cdot Height^c$	a	0.050765	0.030871	0.971	0.26	31.0
			b	1.141709	0.140055			
			c	−0.250187	0.202383			
	Sword fern	$= a \cdot Cover^b \cdot Height^c$	a	0.013492	0.005656	0.979	0.32	23.1
			b	0.907455	0.078963			
			c	0.511214	0.137416			
	Forb	$= a \cdot Cover^b \cdot Height^c$	a	0.043841	0.012741	0.920	0.36	33.8
			b	0.765630	0.073362			
			c	0.224945	0.050597			
	Graminoid	$= a \cdot Cover^b \cdot Height^c$	a	0.012240	0.003973	0.945	0.38	56.3
			b	1.299804	0.095254			
			c	0.085844	0.07546			
	Bramble	$= \frac{a}{1+b \cdot exp^{-c \cdot CH}}$	a	1.132271	0.078635	0.923	0.12	33.0
			b	15.110096	4.215749			
			c	0.520423	0.07042			
	Shrub	$= a \cdot Cover^b \cdot Height^c$	a	0.000120887	0.000045629	0.994	0.01	10.8
			b	1.255475	0.038010			
			c	1.333292	0.111233			
	Total	$= a \cdot Cover^b \cdot Height^c$	a	0.029662	0.012457	0.941	0.55	29.3
			b	0.949564	0.110260			
			c	0.241096	0.054032			
ID	Sword fern	$= a \cdot Cover^b \cdot Height^c$	a	0.004689	0.002191	0.993	0.21	11.7
			b	1.436381	0.048306			
			c	0.407966	0.105510			
	Forb	$= a \cdot Cover^b \cdot Height^c$	a	0.001469	0.000615	0.971	0.34	23.2
			b	1.021933	0.076051			
			c	0.918408	0.072488			
	Graminoid	$= a \cdot Cover^b \cdot Height^c$	a	0.001849	0.000762	0.989	0.24	16.5
			b	0.906781	0.064931			
			c	0.919863	0.107180			
	Bramble	$= a \cdot Cover^b \cdot Height^c$	a	0.002623	0.000539	0.994	0.07	10.7
			b	1.278391	0.038965			
			c	0.400863	0.054239			
	Total	$= a \cdot Cover^b \cdot Height^c$	a	0.006148	0.003314	0.958	0.55	25.6
			b	1.307160	0.129175			
			c	0.225179	0.045990			
Pooled	Sword fern	$= \frac{a}{1+b \cdot exp^{-c \cdot CH}}$	a	7.990414	0.588840	0.932	0.71	44.0
			b	20.531989	5.062166			
			c	0.151918	0.015650			
	Forb	$= a \cdot Cover^b \cdot Height^c$	a	0.011322	0.003521	0.911	0.48	39.8
			b	0.958610	0.067395			
			c	0.418276	0.049445			
	Graminoid	$= a \cdot Cover^b \cdot Height^c$	a	0.008294	0.002681	0.954	0.40	44.9
			b	1.098820	0.075305			
			c	0.352346	0.057777			
	Bramble	$= a \cdot Cover^b \cdot Height^c$	a	0.004285	0.001250	0.982	0.12	33.5
			b	1.082031	0.038280			
			c	0.499640	0.081455			
	Total	$= a \cdot Cover^b \cdot Height^c$	a	0.016582	0.005320	0.946	0.56	28.9
			b	1.089033	0.081624			
			c	0.225714	0.035750			

CW: coastal wet site; ID: inland dry site; Pooled: pooled data set combining both sites; Cover: vegetation ground cover (%); Height: vegetation height (cm); C·H: product of cover and height; SE: standard error; R^2: coefficient of determination; RMSE: root mean square error (Mg ha^{-1}); CV: coefficient of variation (%). For all parameter estimates $p < 0.05$.

Methods

2 sites

Coast: FSP-16, $SR_1$17, $SR_2$18

Inland: FSP-17, $SR_1$18, $SR_2$19

4 treatments : OOO, 1OO, 11O and 111

4 replications

Use site/species biomass functions

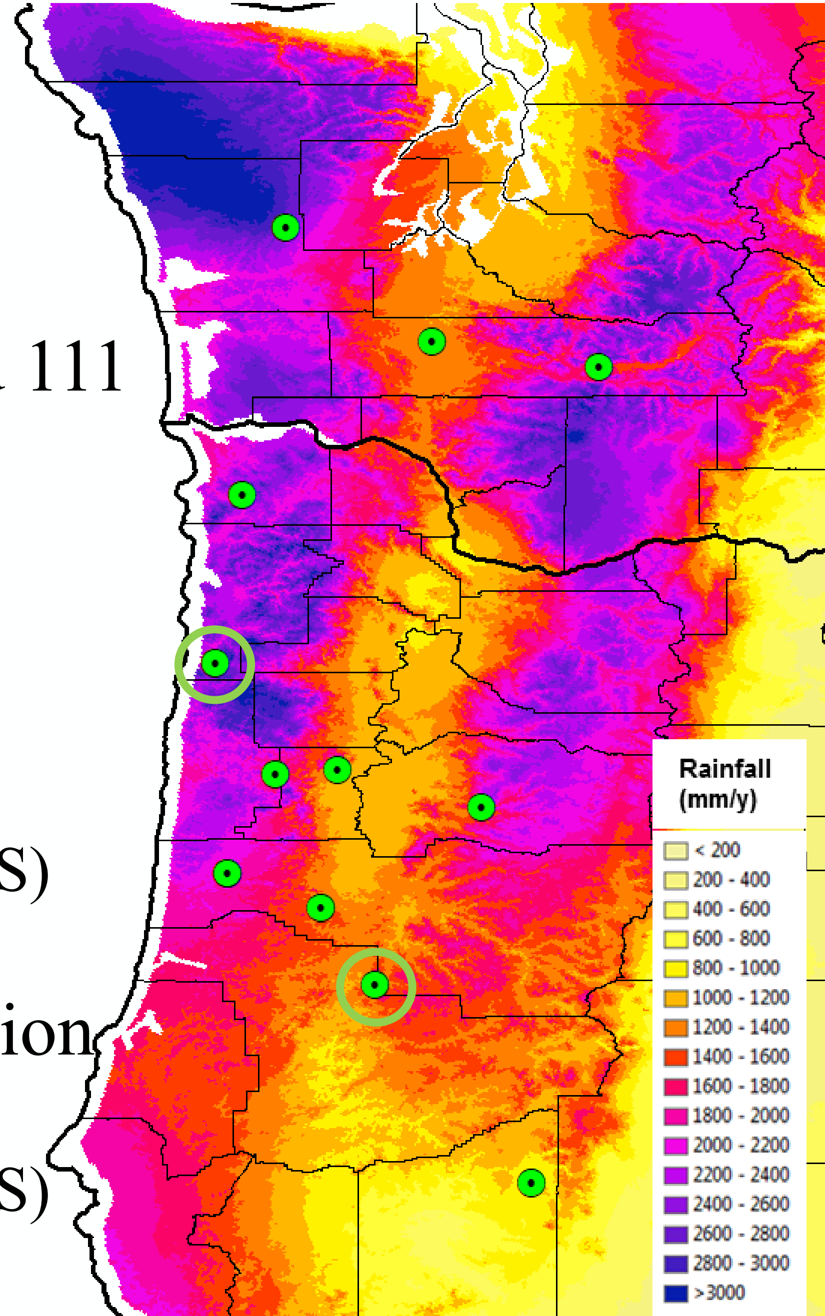
Seedlings (WH and DF)

Vegetation (Forb, Fern, Grass, Shrub, V/S)

Use site-specific nutrient concentration

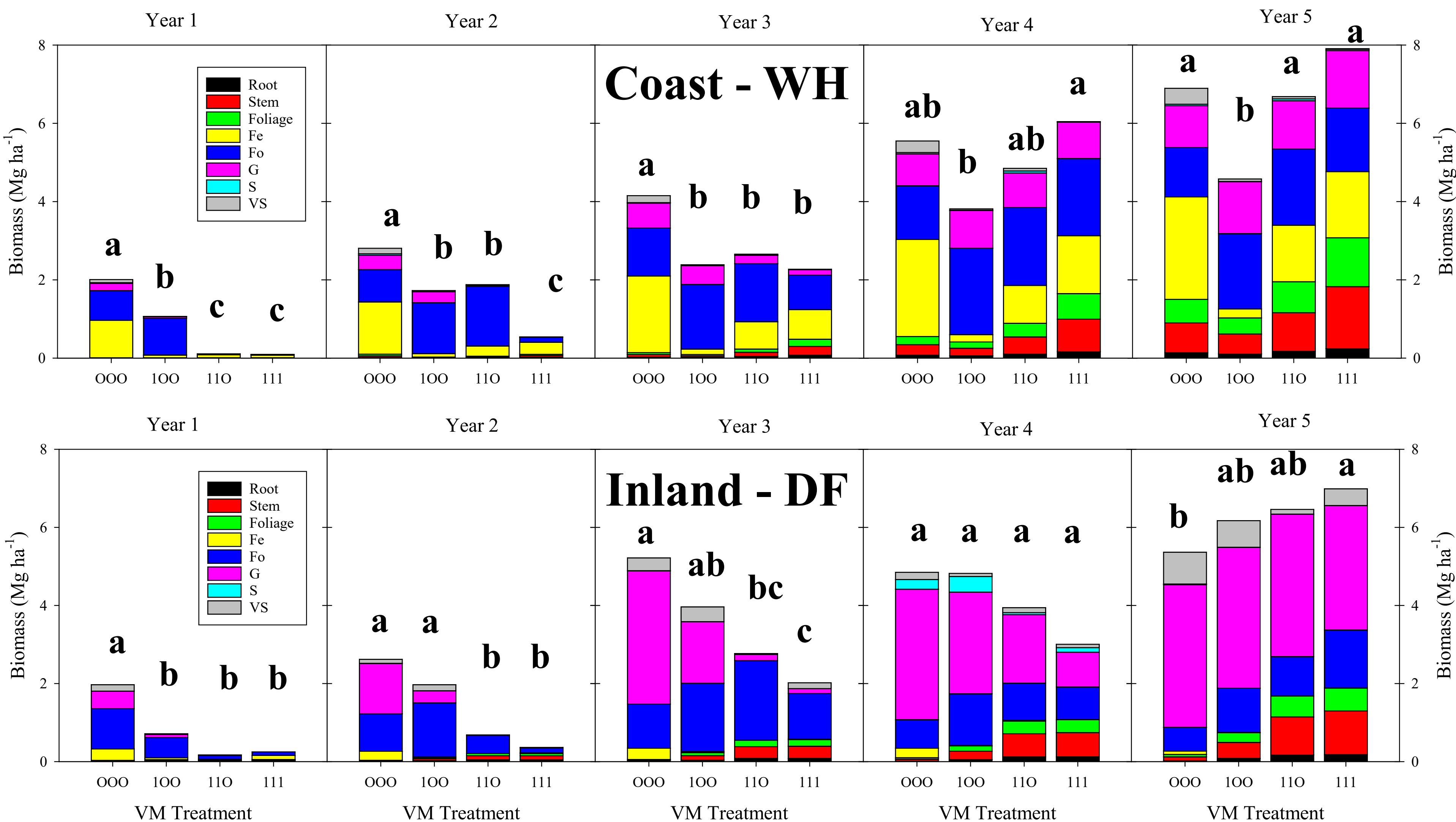
Seedlings (WH and DF)

Vegetation (Forb, Fern, Grass, Shrub, V/S)

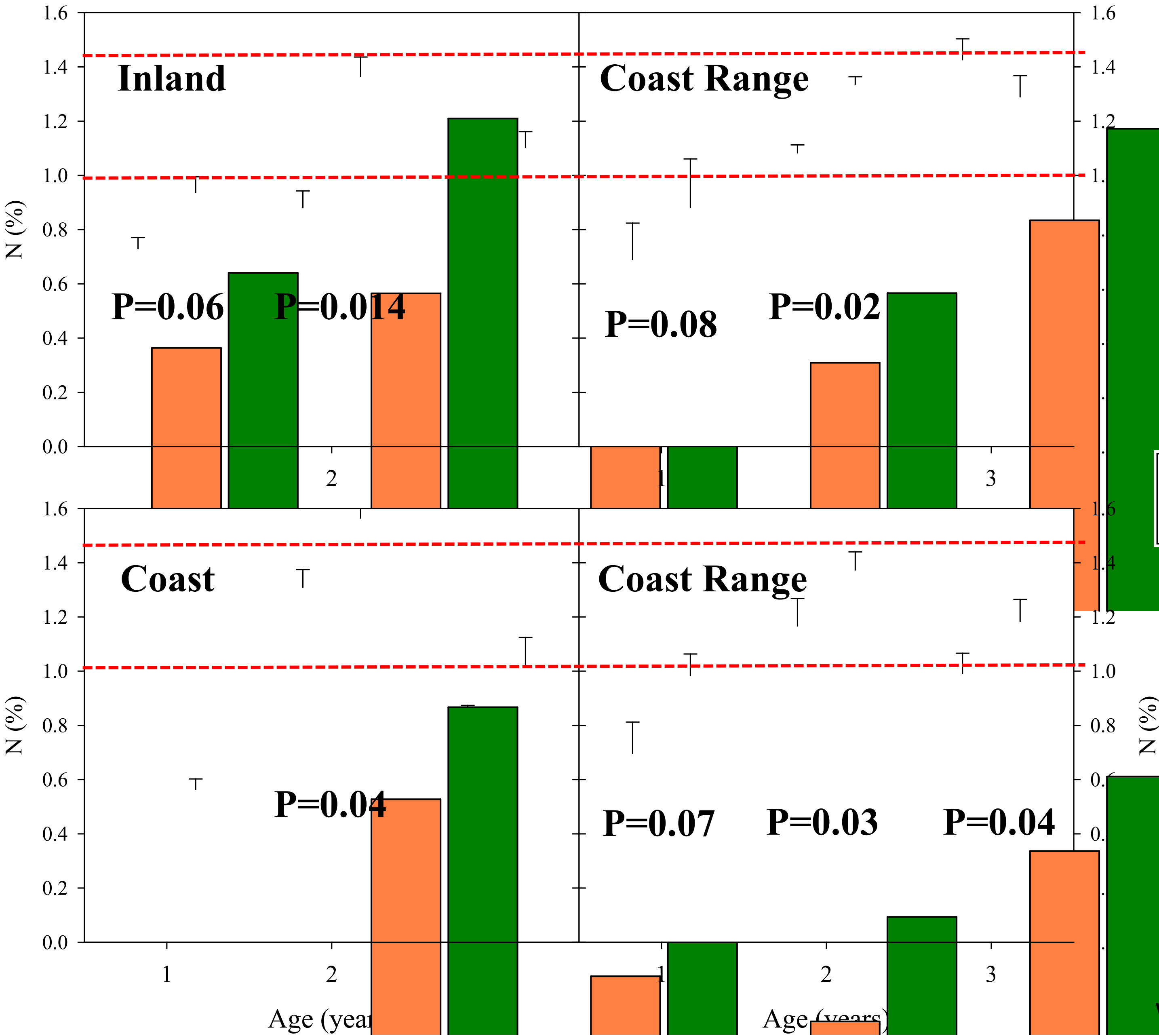


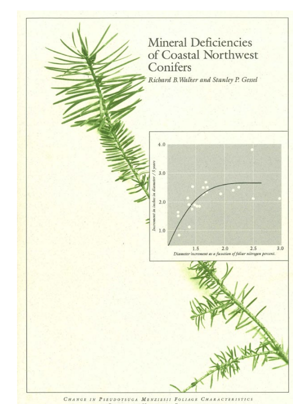
Results

Biomass



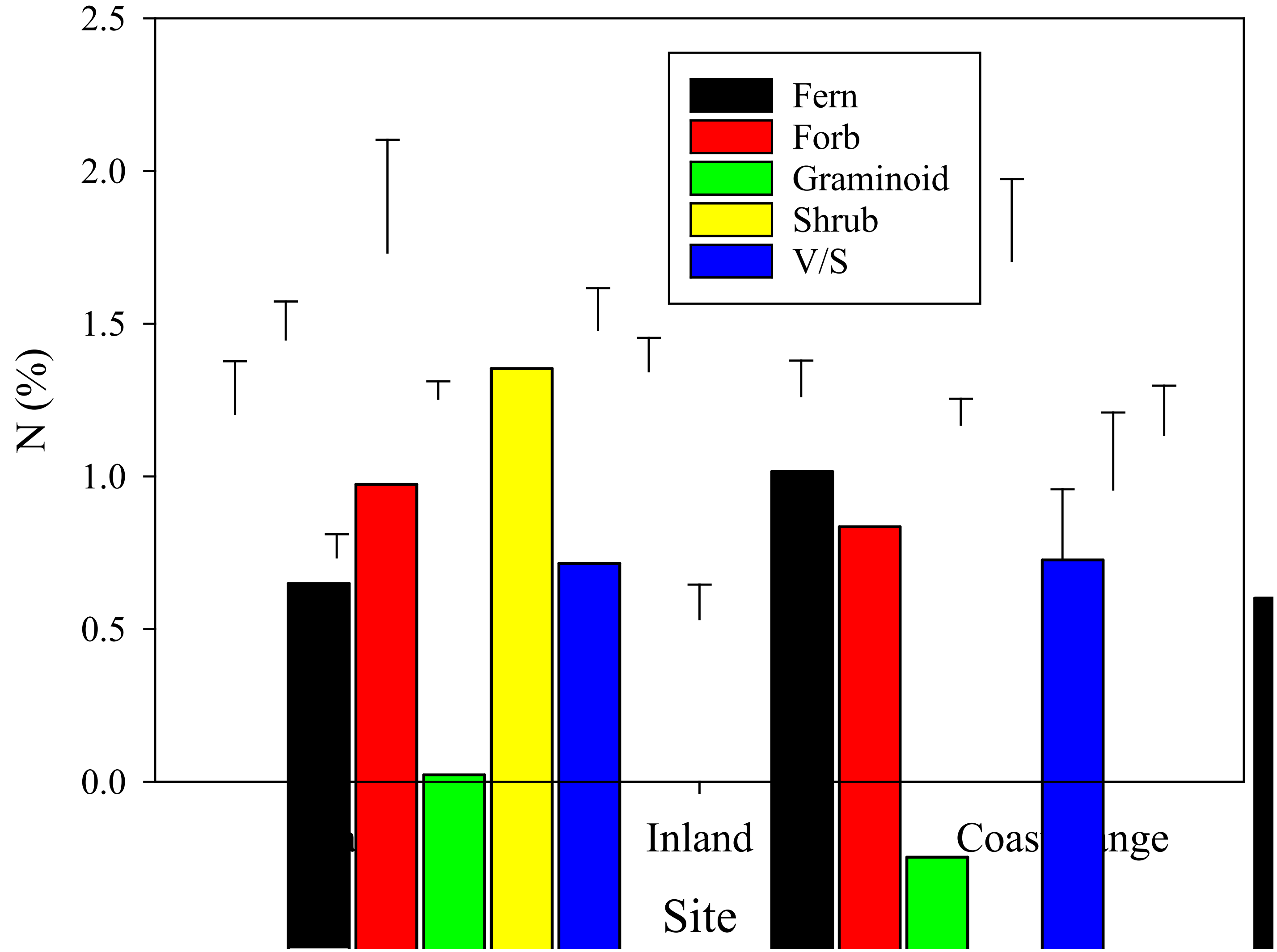
Results Seedling Nitrogen Concentration



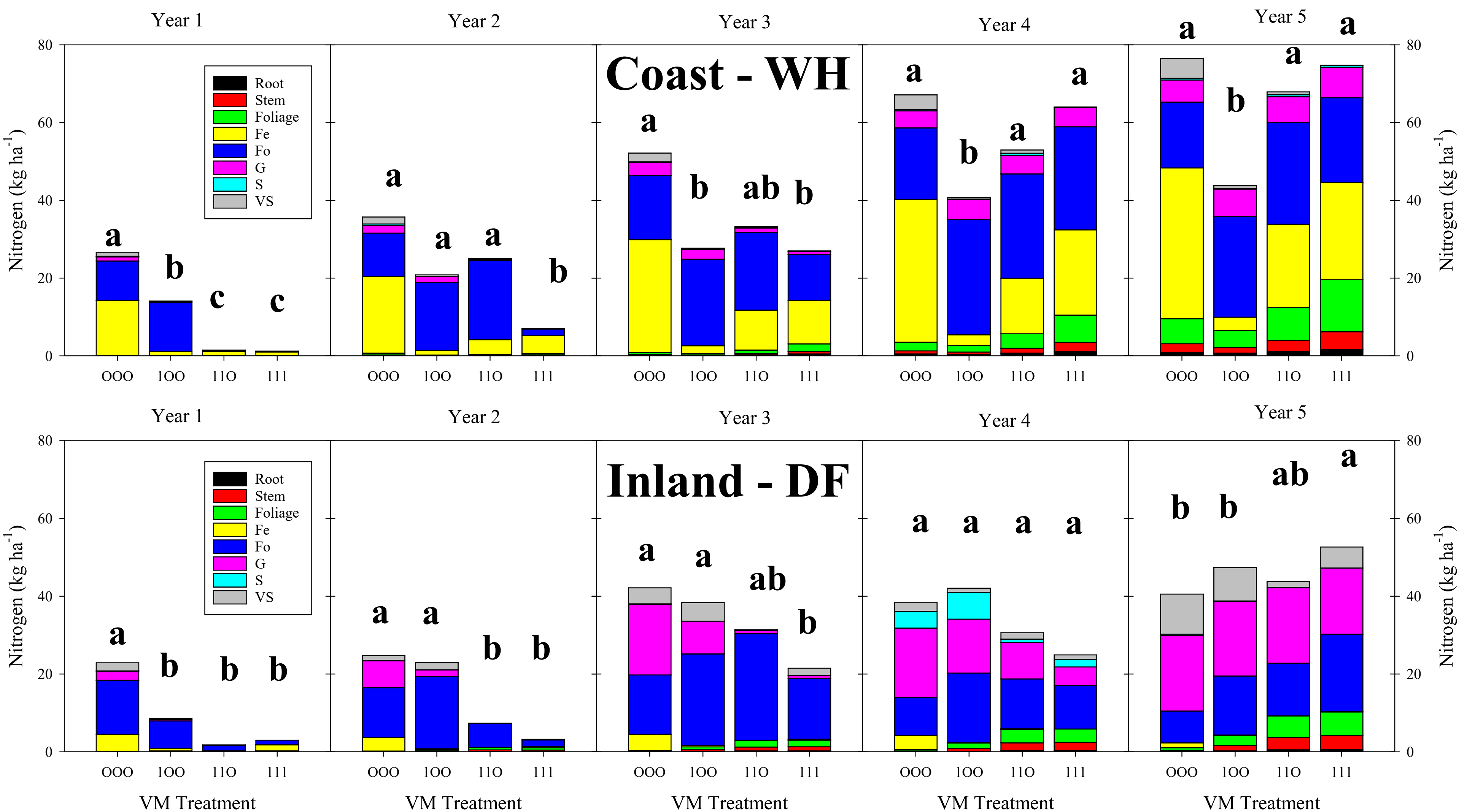


Walker and Gessel (1990)

Results Vegetation Nitrogen Concentration



Results


Year 1
Year 2
Year 3
Year 4
Year 5
Coast - WH
Inland - DF
Root
Stem
Foliage
Fe
Fo
G
S
VS
Nitrogen (kg ha-1)
VM Treatment
000
100
110
111
a
b
c
ab

Conclusions

- VM treatment effects:
  - For DF and WH at both sites:
    - Increased [N] at year 1, 2 and 3
    - 1 - 2 years after treatment: No differences in total (vegetation + seedling) biomass stock and Nitrogen content


Thanks !!


Thanks !!
Cl
T
Ca
Em
Cl2
Je
C
P
23
V
Vanadium
Transition Metal
12
Mg
Magnesium
Alkaline Earth Metal
75
Re
Rhenium
Transition Metal
6
C
Carbon
Nonmetal