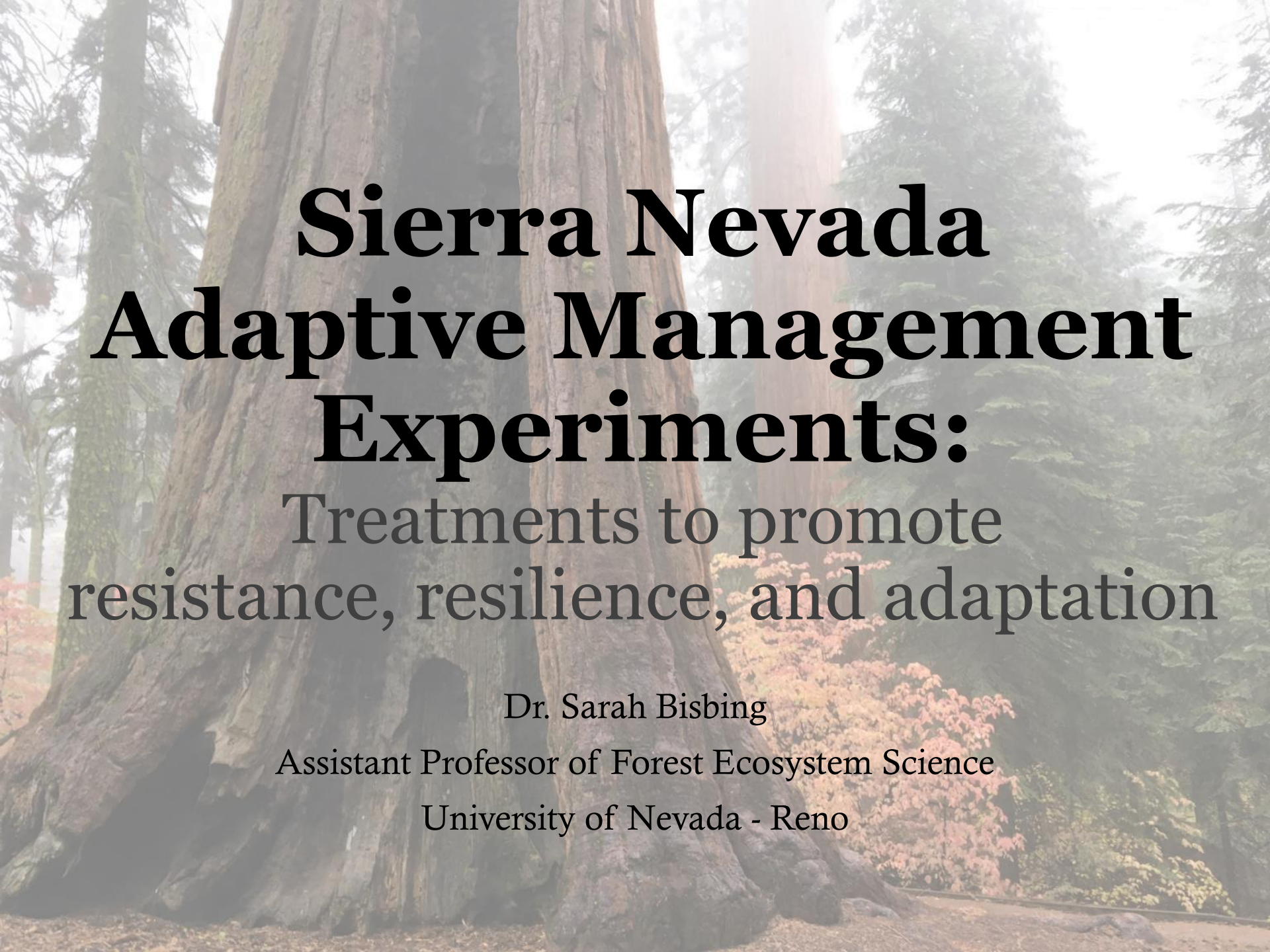

Sierra Nevada Adaptive Management Experiments:

Treatments to promote resistance, resilience, and adaptation

Dr. Sarah Bisbing

Assistant Professor of Forest Ecosystem Science

University of Nevada - Reno

Project Partners

Project Overview

Climate change disruption in Sierra Nevada forests

Project Objectives:

- Quantify **treatment effectiveness and forest response** to climate change across latitudinal and elevational extents of the Sierra mixed-conifer forest
- Track **stand dynamics**, mortality, productivity under ongoing climate change
- Inform **seed zone regulations** and increasing **forest resilience** by matching provenances to current and future climates
- Identify **solutions and target structures** for addressing the challenging task of preparing and managing for ongoing climate change

1) How have and will climate change and altered disturbance regimes influence community composition & stand dynamics?

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2) What effects will these changes have on tree regeneration, growth, and survival in the future?

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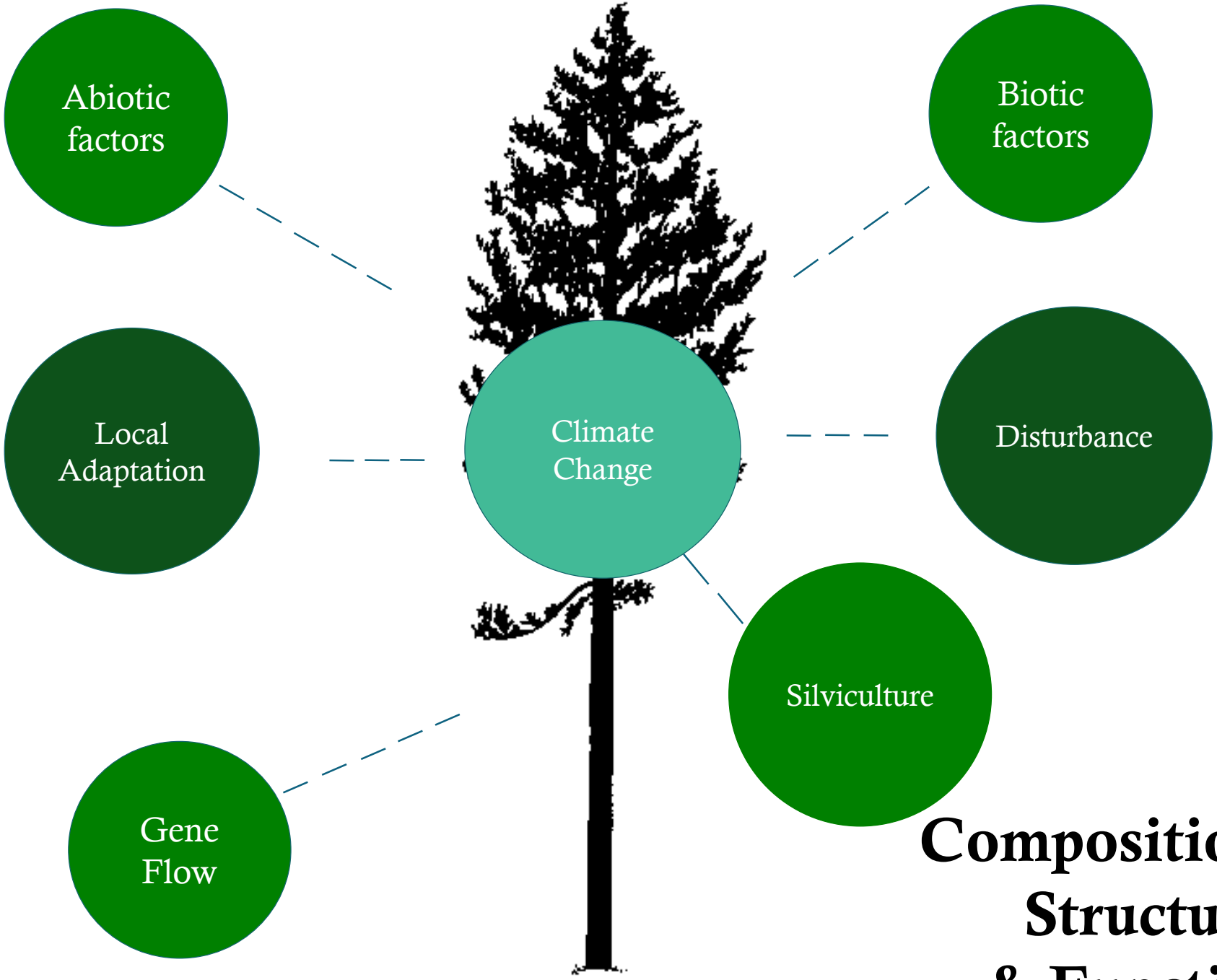
3) What species (and populations) will be best suited for future conditions?


Abiotic factors
Biotic factors
Local Adaptation
Climate Change
Disturbance
Silviculture
Gene Flow
Composition, Structure, & Function

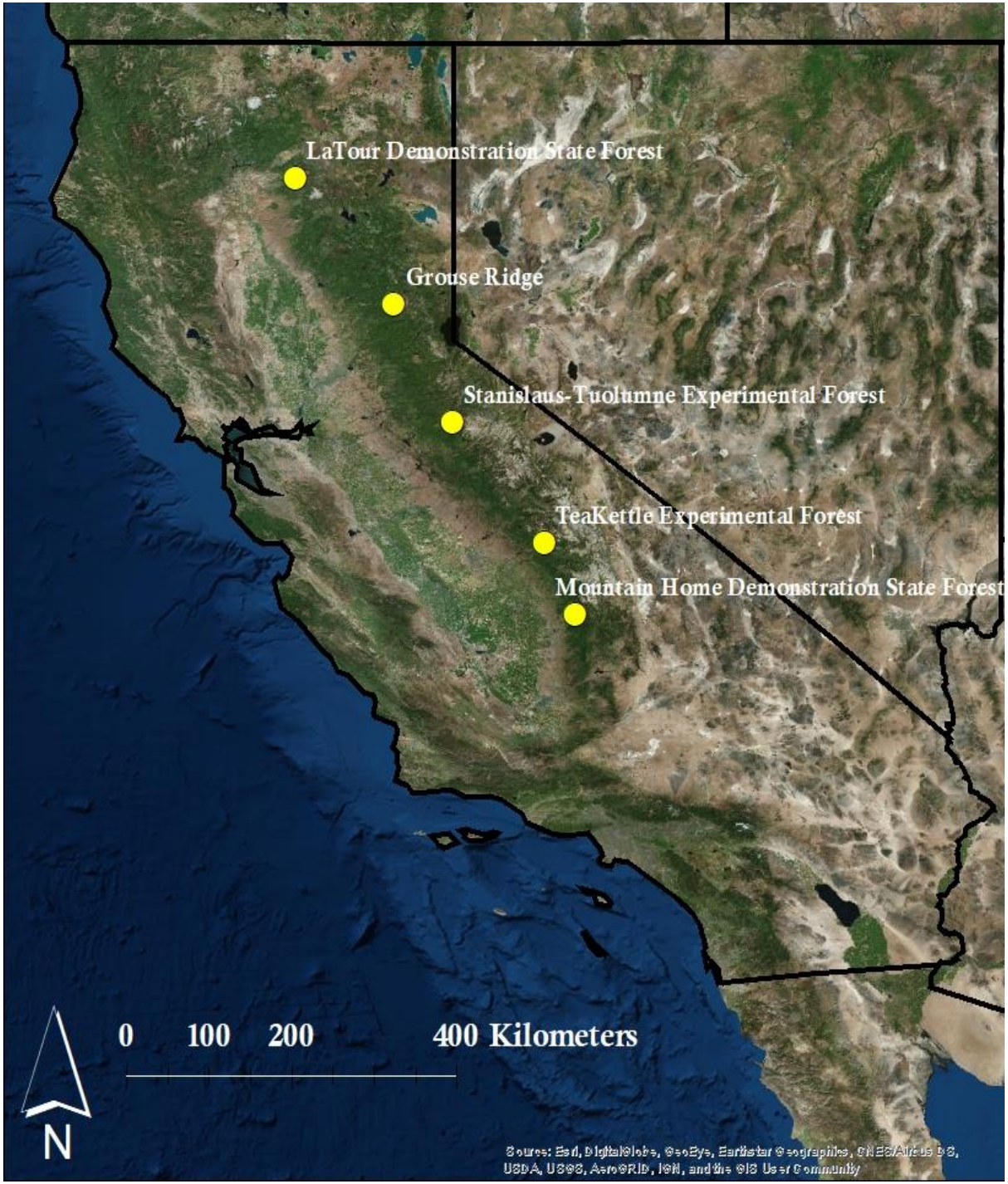
Planning & Design

Treatment Areas

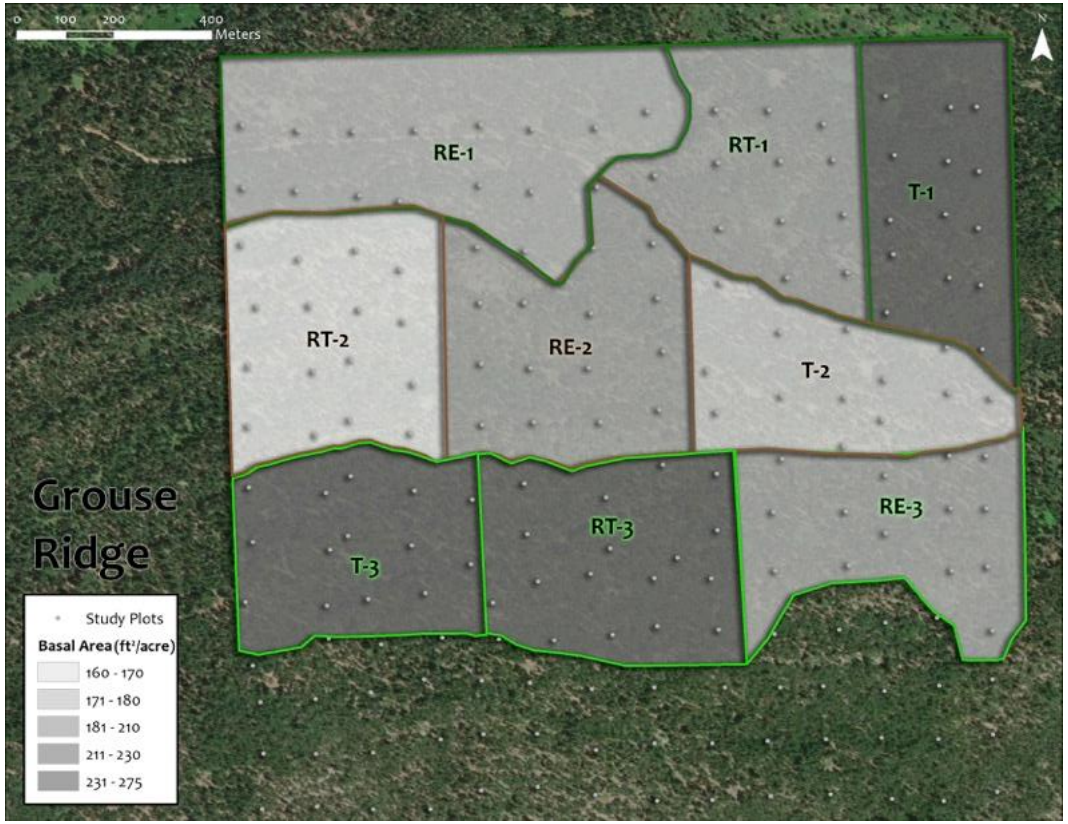
5 properties

4° Latitude

5,200-7,500 ft elevation



Treatment Design

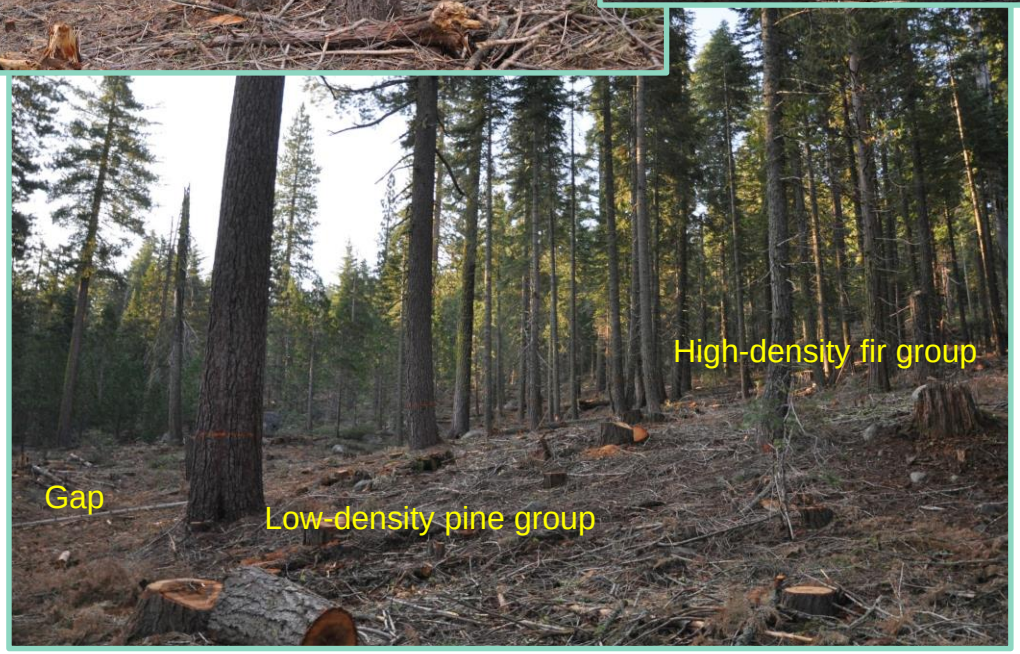


- 240 acre treatment areas
- 2 areas
  - Prescribed burn
  - Unburned
- Randomized block
  - elevation
- Treatments:
  - Resilience
  - Resistance
  - Transition
  - (Control)

Treatment Design

Transition

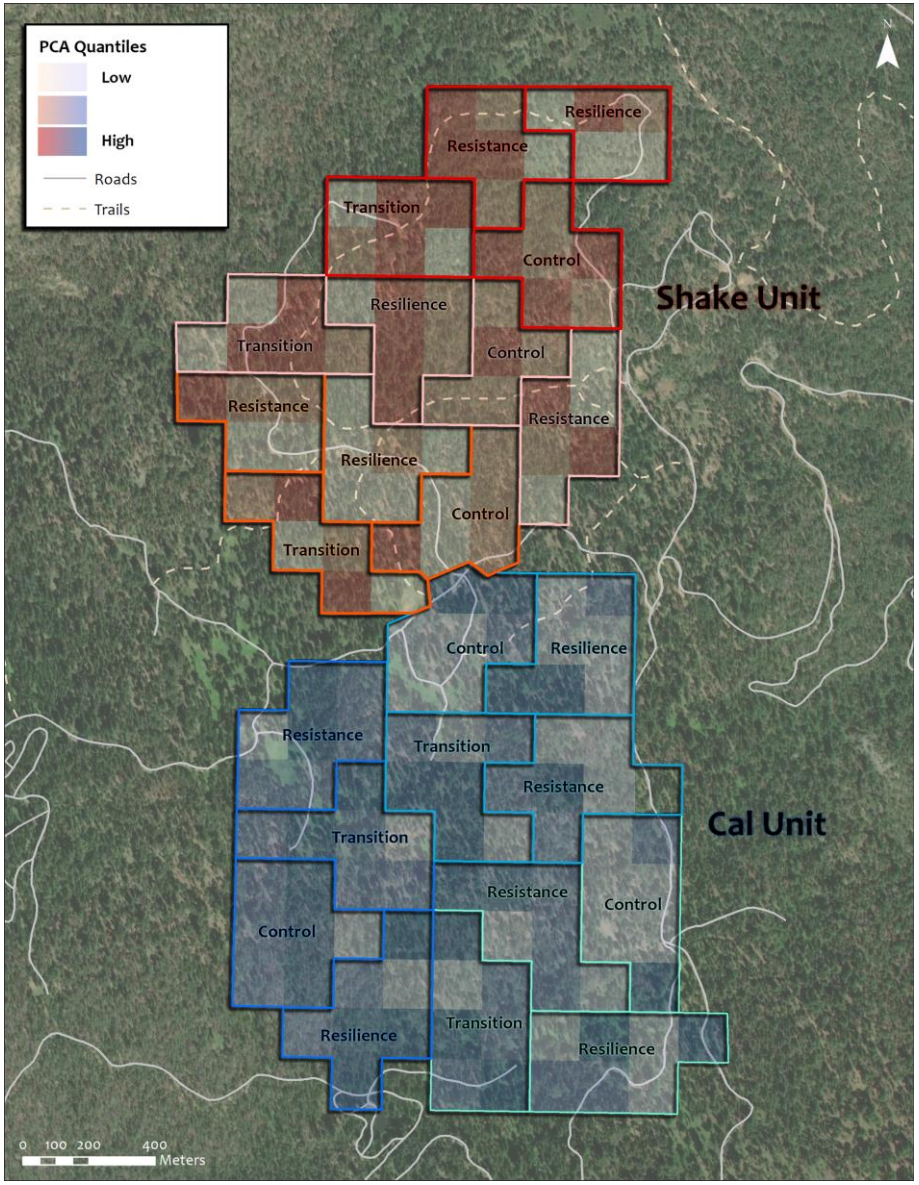
Resistance

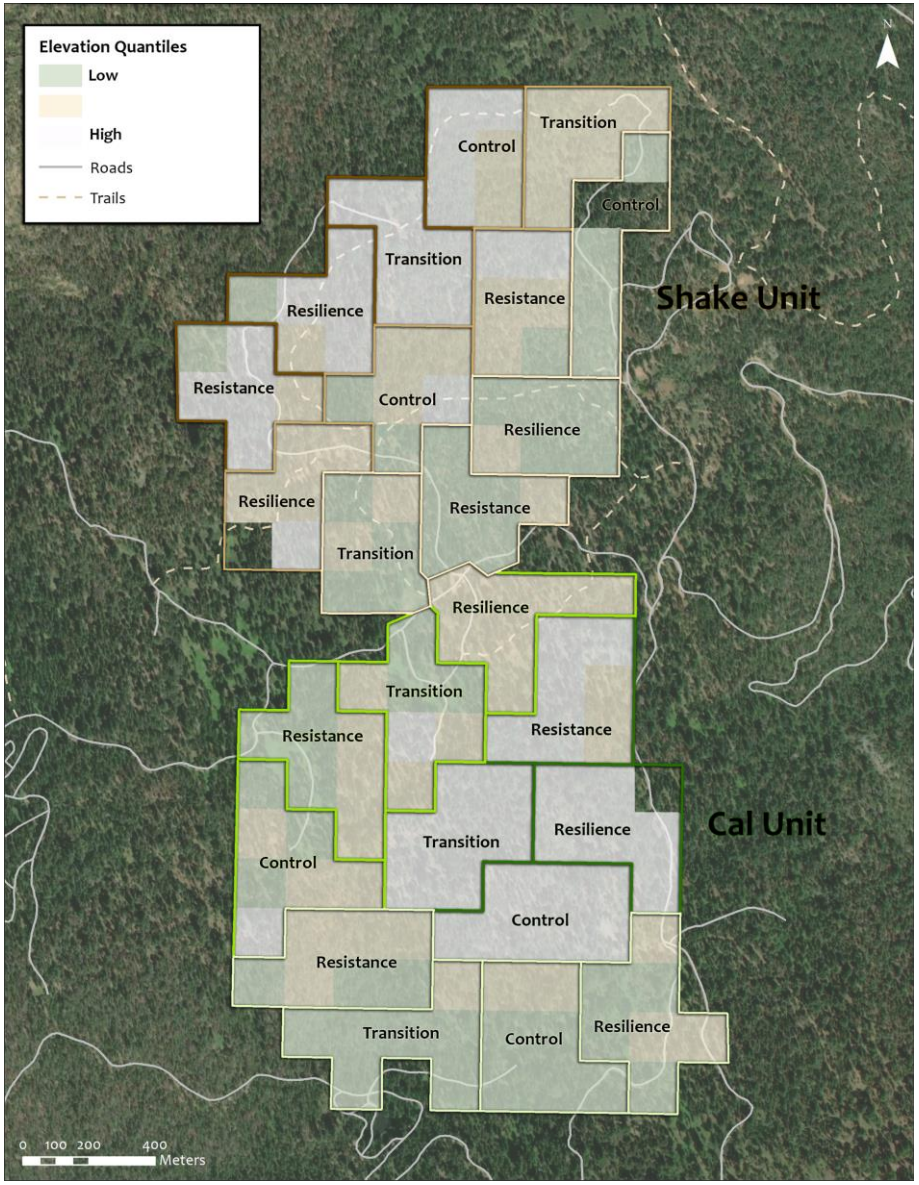


Resilience

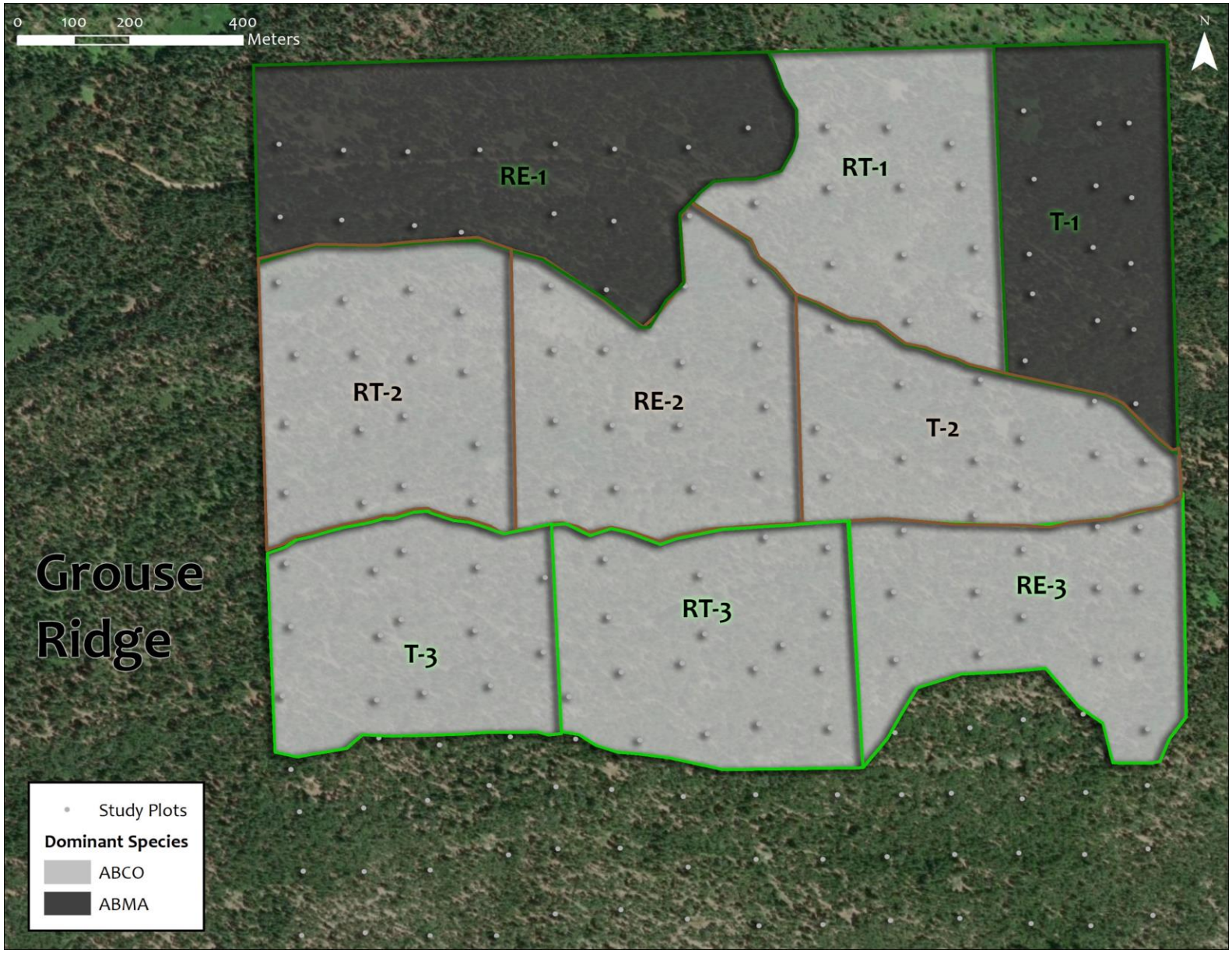
Photos of STEF by Eric Knapp

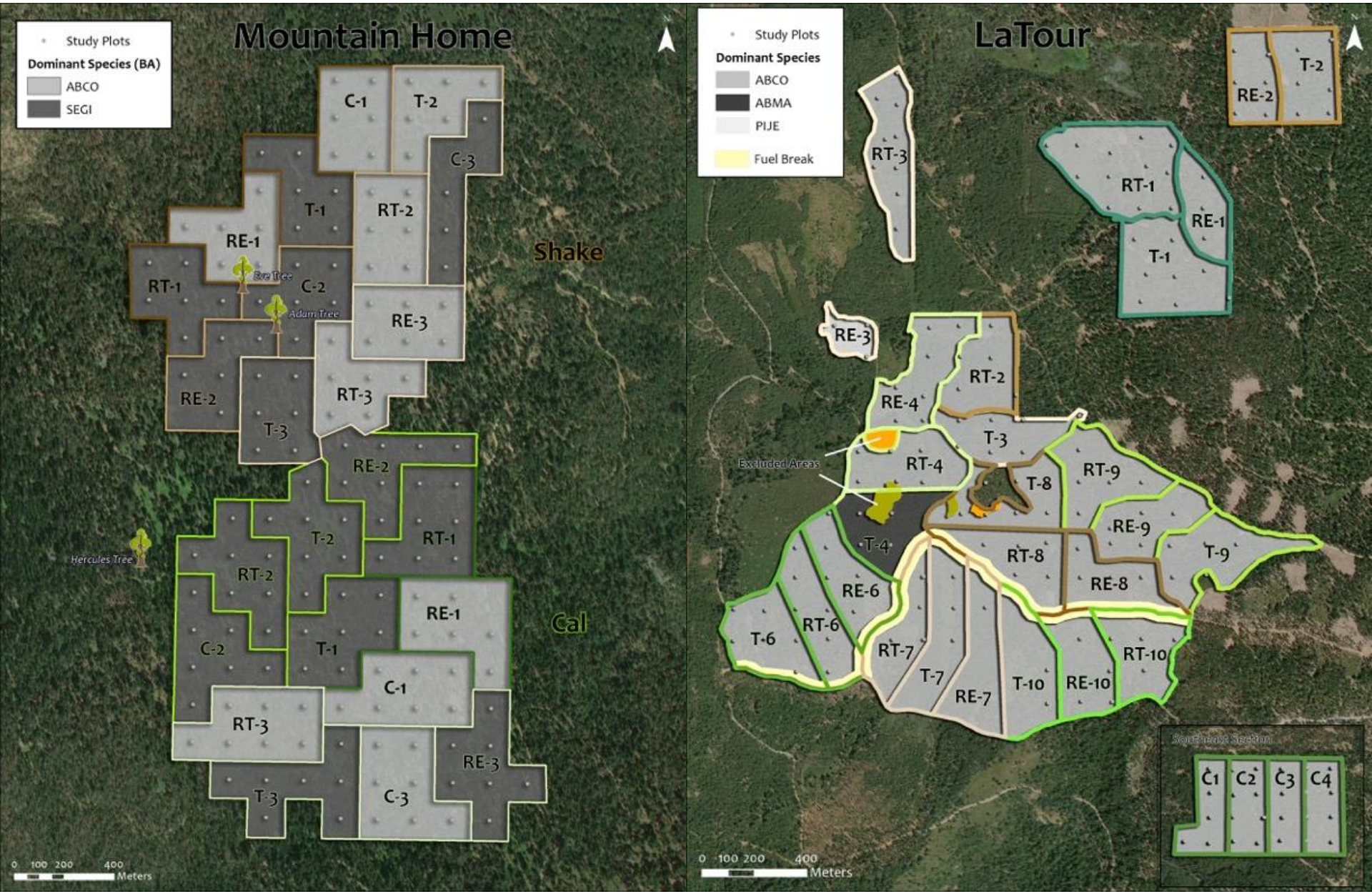
Blocking


PCA Quantiles
Low
High
Roads
Trails
Shake Unit
Cal Unit
Resilience
Resistance
Transition
Control
0 100 200 400
Meters

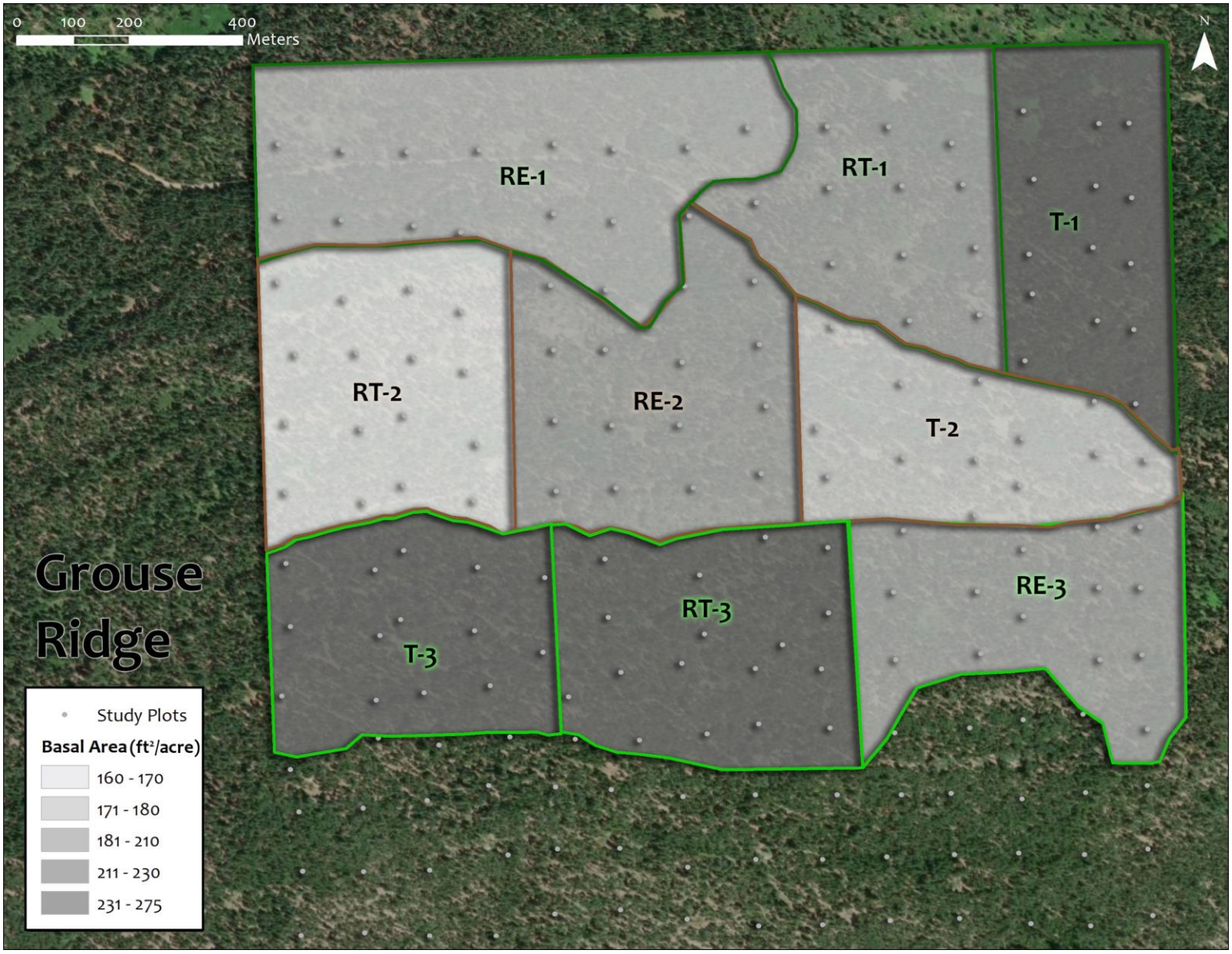

Elevation Quantiles
Low
High
Roads
Trails
Shake Unit
Cal Unit
Control
Transition
Resistance
Resilience
0 100 200 400
Meters

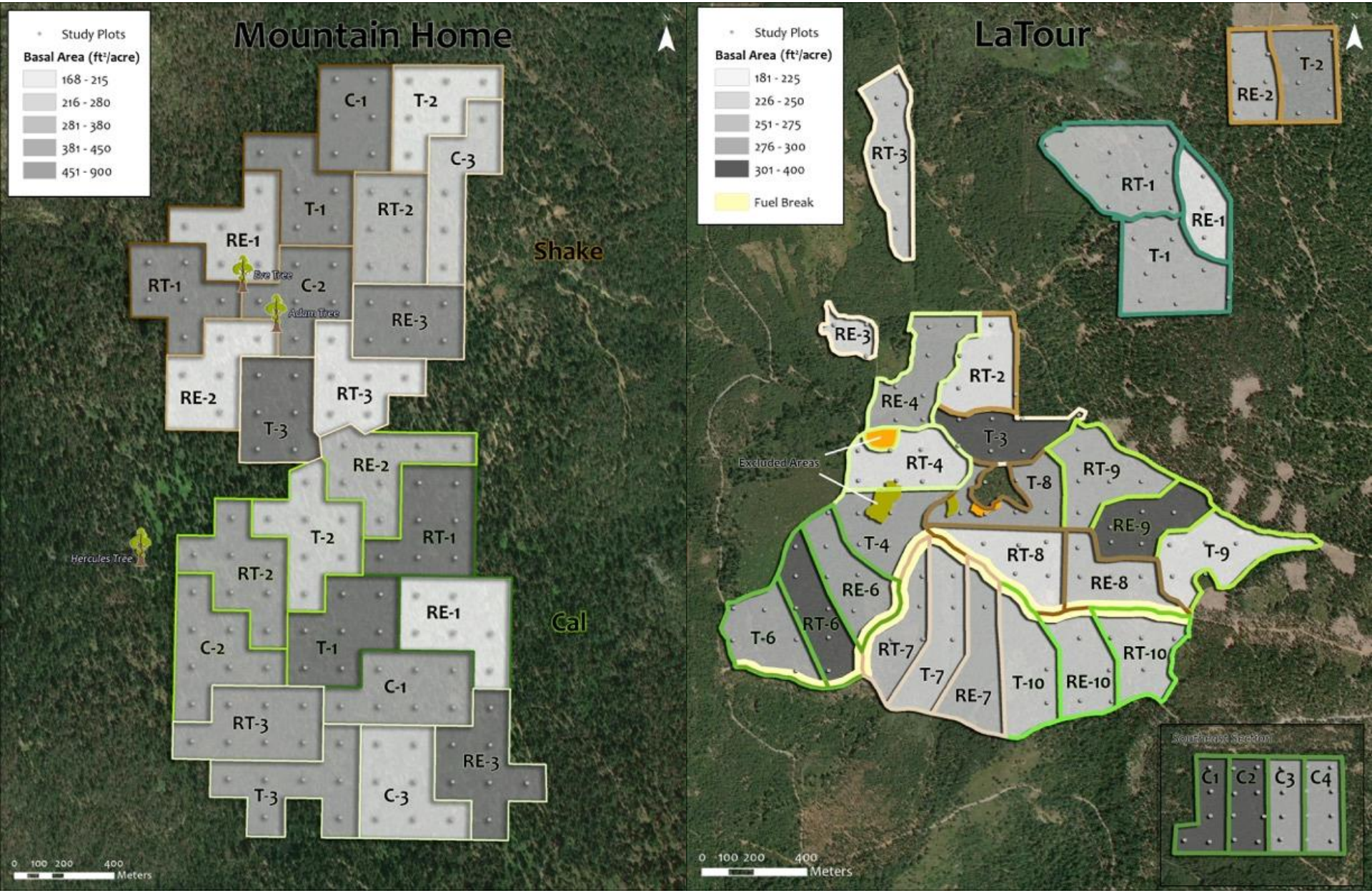
Grouse Ridge (Berkeley)

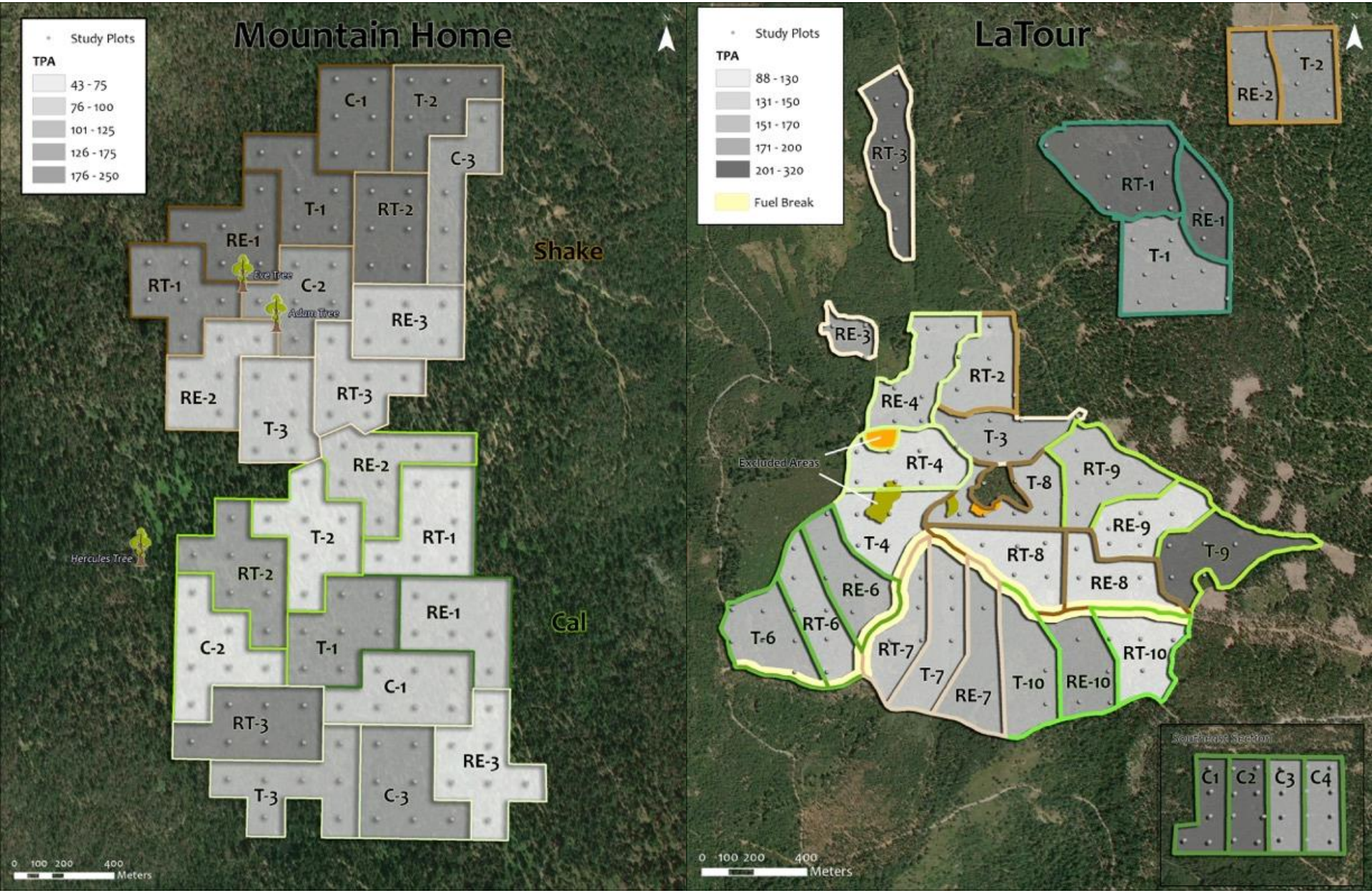



Mountain Home
Study Plots
Dominant Species (BA)
ABCO
SEGI
C-1
T-2
C-3
T-1
RT-2
RE-1
Eve Tree
RT-1
C-2
Adam Tree
RE-3
RE-2
T-3
RT-3
Shake
RE-2
T-2
RT-1
Hercules Tree
RT-2
RE-1
C-2
T-1
C-1
Cal
RT-3
RE-3
T-3
C-3
0 100 200 400
Meters
LaTour
Study Plots
Dominant Species
ABCO
ABMA
PIJE
Fuel Break
RT-3
T-2
RE-2
RT-1
RE-1
T-1
RE-3
RT-2
RE-4
T-3
Excluded Areas
RT-4
T-8
RT-9
RE-9
T-4
RT-8
T-9
RE-8
RE-6
RT-6
T-6
RT-7
T-7
RE-7
T-10
RE-10
RT-10
C1
C2
C3
C4
0 100 200 400
Meters

Grouse Ridge (Berkeley)




Mountain Home
Study Plots
Basal Area (ft²/acre)
168 - 215
216 - 280
281 - 380
381 - 450
451 - 900
C-1
T-2
C-3
T-1
RT-2
RE-1
RT-1
C-2
Eve Tree
Adam Tree
RE-3
RE-2
RT-3
T-3
Shake
RE-2
T-2
RT-1
Hercules Tree
RT-2
RE-1
C-2
T-1
C-1
RT-3
RE-3
T-3
C-3
Cal
0 100 200 400
Meters
LaTour
Study Plots
Basal Area (ft²/acre)
181 - 225
226 - 250
251 - 275
276 - 300
301 - 400
Fuel Break
RT-3
RE-2
T-2
RT-1
RE-1
T-1
RE-3
RT-2
RE-4
T-3
Excluded Areas
RT-4
T-8
RT-9
RE-9
T-4
RT-8
T-9
RE-8
RE-6
T-6
RT-6
RT-7
T-7
RE-7
T-10
RE-10
RT-10
Southeast Section
C1
C2
C3
C4
0 100 200 400
Meters


Mountain Home
Study Plots
TPA
43 - 75
76 - 100
101 - 125
126 - 175
176 - 250
C-1
T-2
C-3
T-1
RT-2
RE-1
RT-1
Eve Tree
C-2
Adam Tree
RE-3
RE-2
RT-3
T-3
Shake
RE-2
T-2
RT-1
Hercules Tree
RT-2
RE-1
C-2
T-1
C-1
RT-3
RE-3
T-3
C-3
Cal
0 100 200 400
Meters
LaTour
Study Plots
TPA
88 - 130
131 - 150
151 - 170
171 - 200
201 - 320
Fuel Break
RT-3
RE-2
T-2
RT-1
RE-1
T-1
RE-3
RT-2
RE-4
T-3
Excluded Areas
RT-4
T-8
RT-9
RE-9
T-4
RT-8
T-9
RE-8
RE-6
T-6
RT-6
RT-7
T-7
RE-7
T-10
RE-10
RT-10
Southeast Section
C1
C2
C3
C4
0 100 200 400
Meters

Reforestation & Provenance Trials

1) How have climate change and altered disturbance regimes influenced community composition & stand dynamics?

2) What effects will these changes have on tree regeneration, growth, and survival in the future?

3) What species (and populations) will be best suited for future conditions?

Transition Treatment:

seed zone common garden study

Buck et al. 1970

Transition Treatment:

seed zone common garden study

	Elevation (ft)																
	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000	8500	9000	9500	10000
Pinus ponderosa																	
*Pseudotsuga menziesii**																	
Calocedrus decurrens																	
Quercus kelloggii																	
Abies concolor																	
Pinus lambertiana																	
*Sequoiadendron giganteum***																	
Pinus jeffreyi																	
Abies magnifica																	
Pinus contorta																	
Tsuga mertensiana																	
Pinus monticola																	

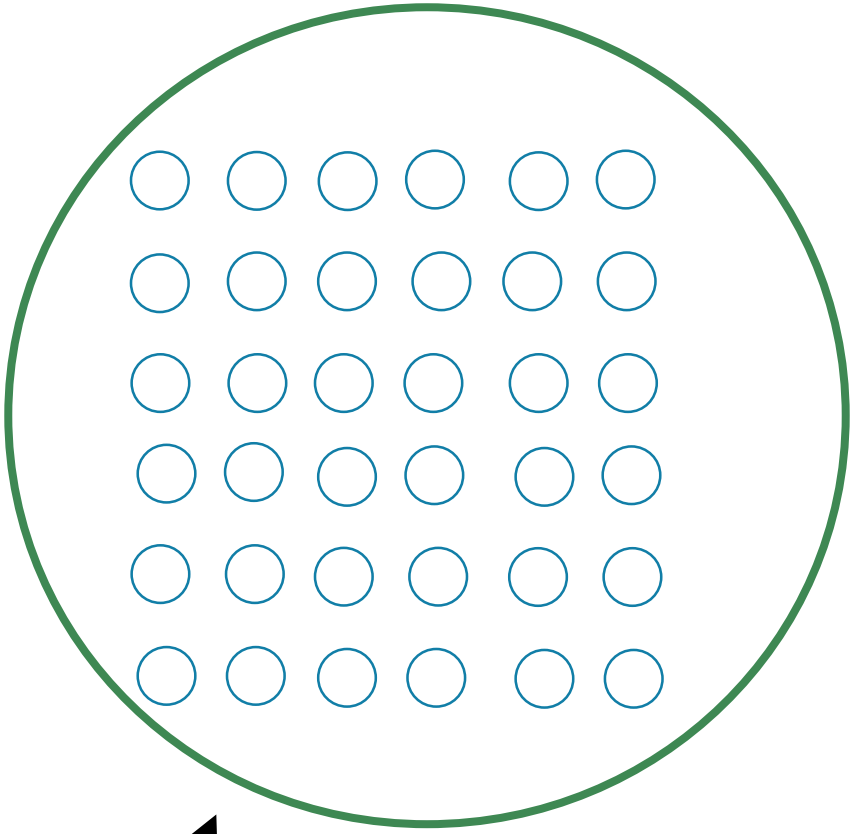
Distributions from Arno's Discovering Sierra Trees - does not account for Cascades distributions

**Patchy distribution south of Yosemite*

***Limited to 36-38 degrees latitude*

Buck et al. 1970

Transition Treatment: seed zone common garden study

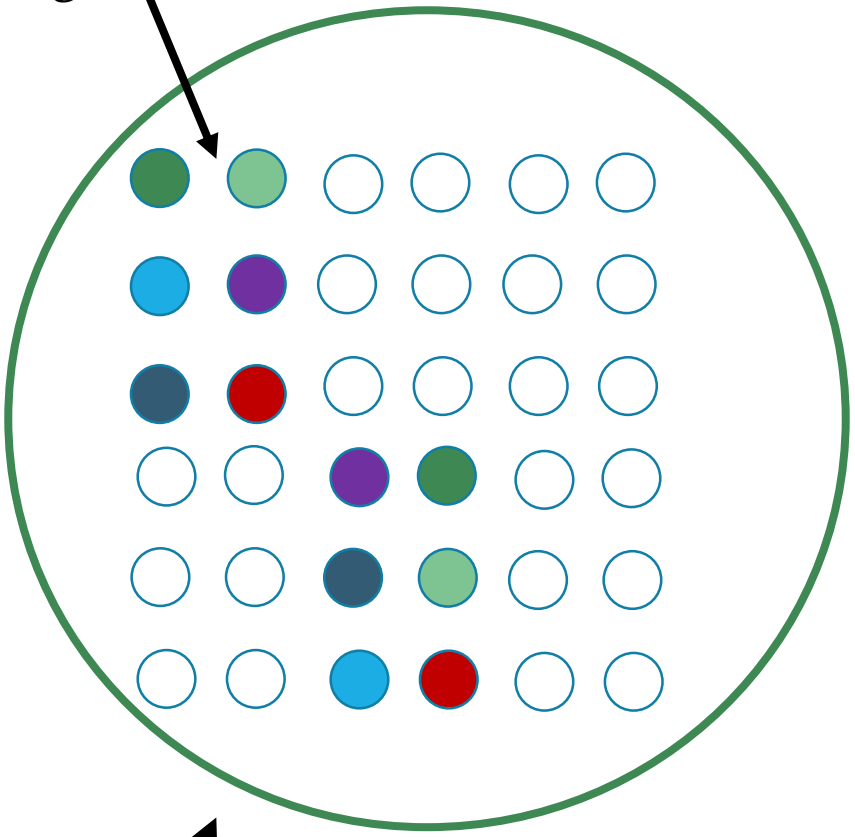


1 ac gaps

- Fully reciprocal
- 12 provenances per species
- 6 species
- Gradient of climate conditions

Transition Treatment: seed zone common garden study

Randomized block design



1 ac gaps

Seedlings per garden:
6 species x
12 provenances/species x
24 individuals/provenance =
1,728 seedlings

Seedlings per property:
1,728 seedlings per garden x
6 gaps/property =
~10,400 seedlings

= *Pinus jeffreyi*

= *Pinus ponderosa*

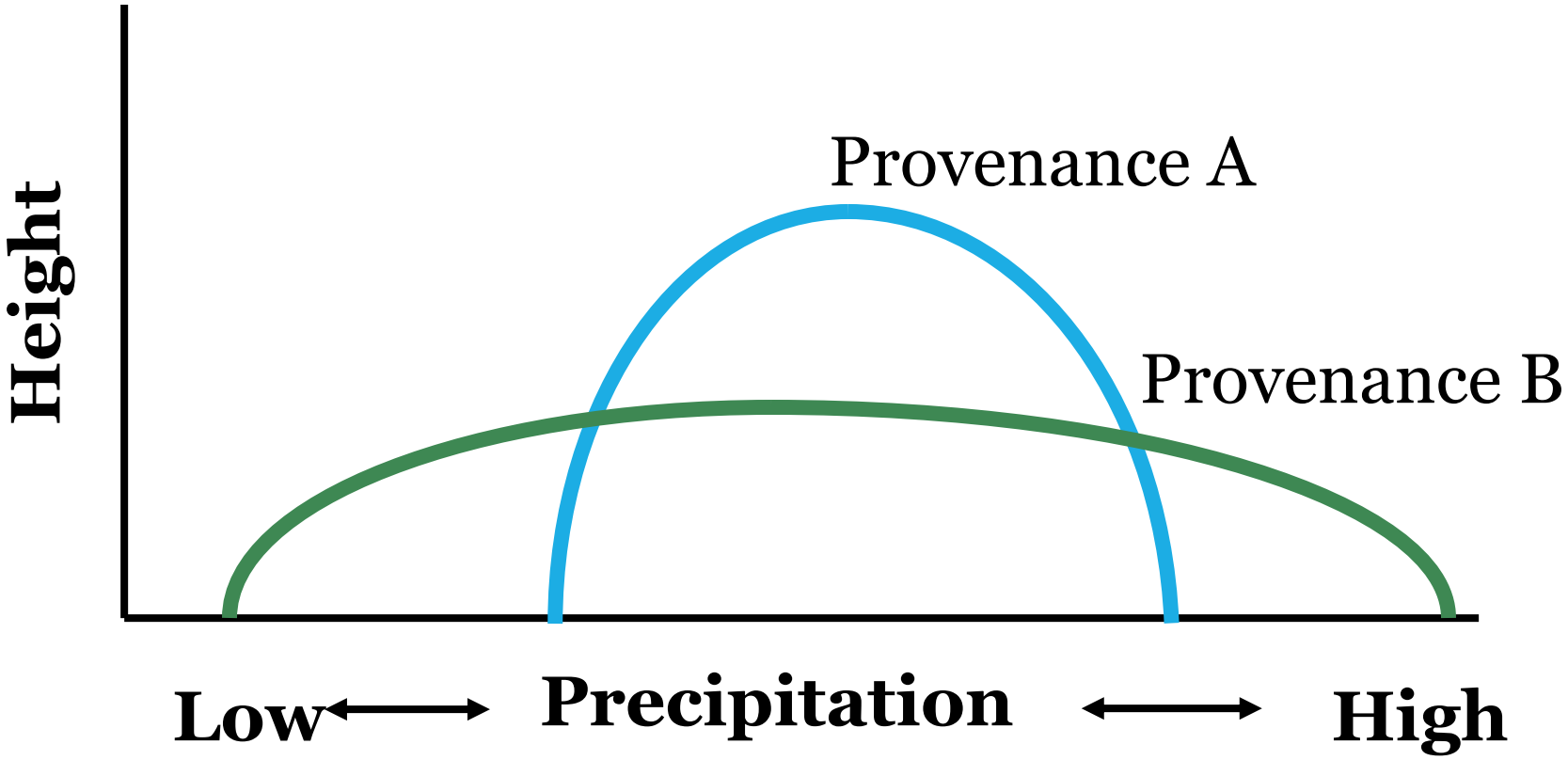
= *Calocedrus decurrens*

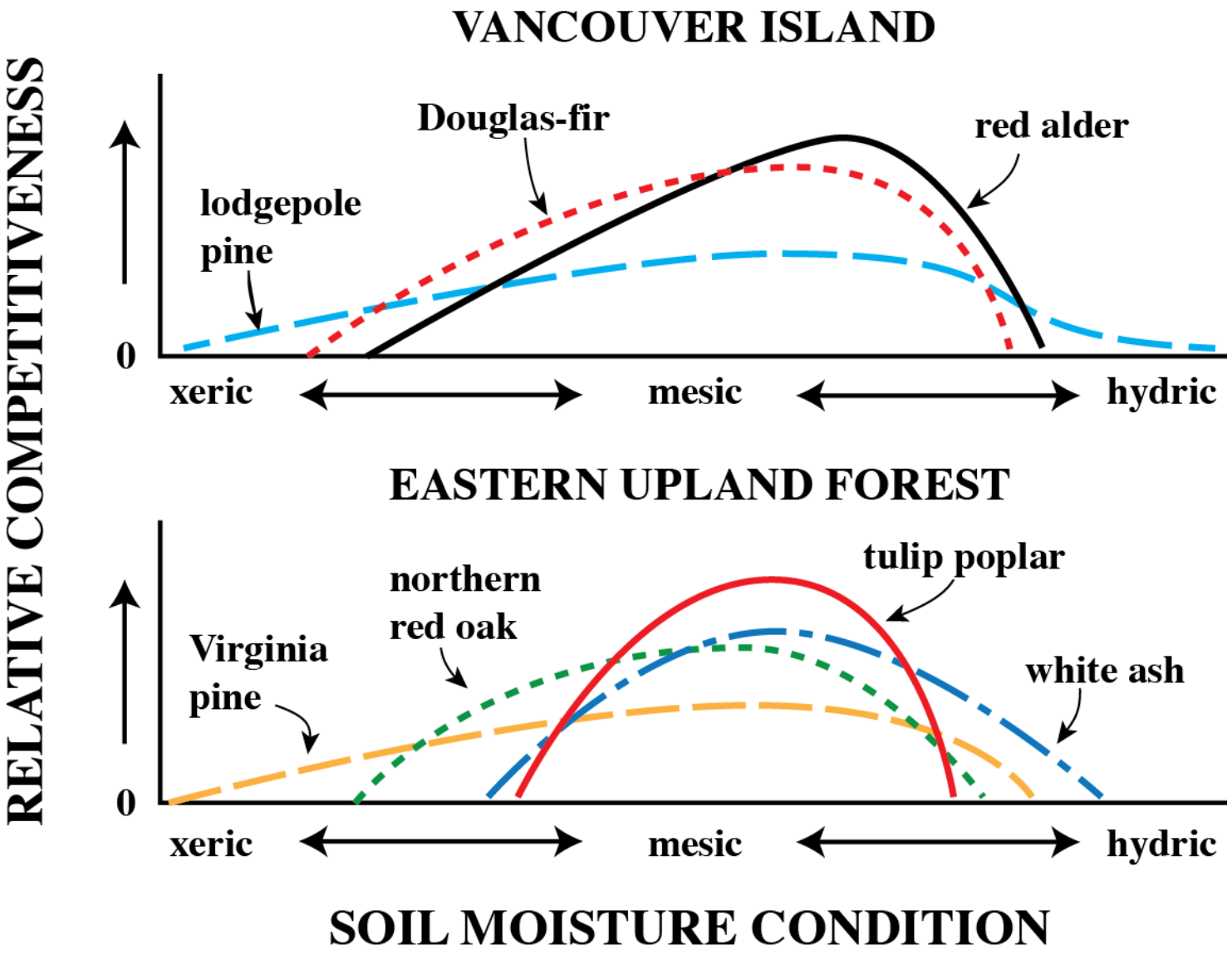
= *Pinus lambertiana*

= *Sequoiadendron giganteum*

= *Quercus kellogii (or PSMA)*

Provenance Climate Variability

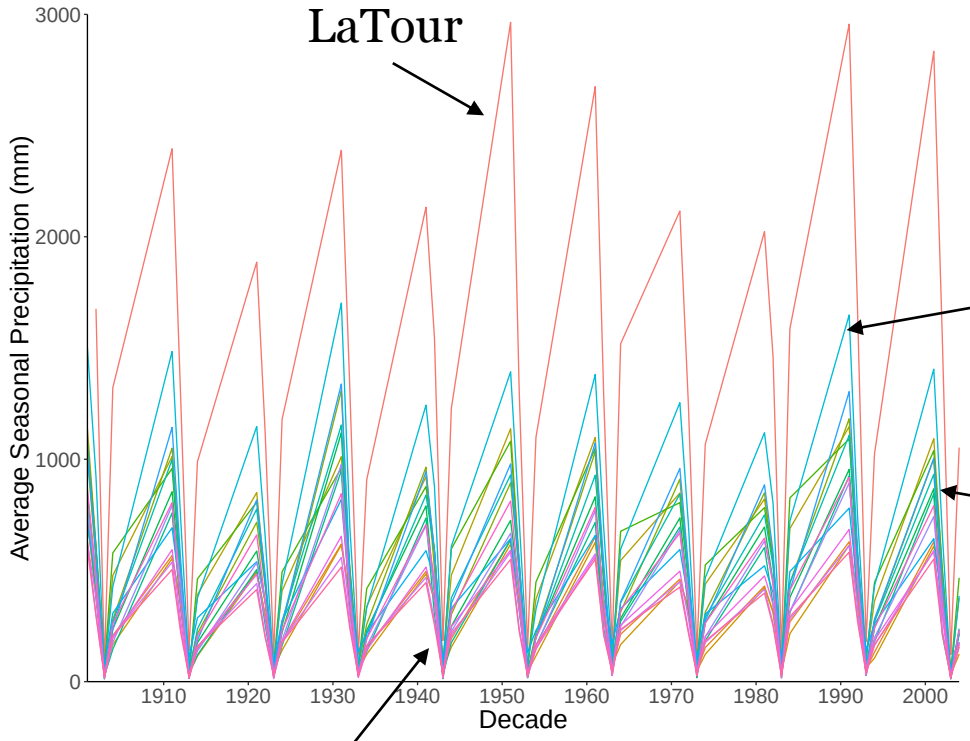




Adapted From: Oliver and Larson 1996: Forest Stand Dynamics

Calocedrus decurrens

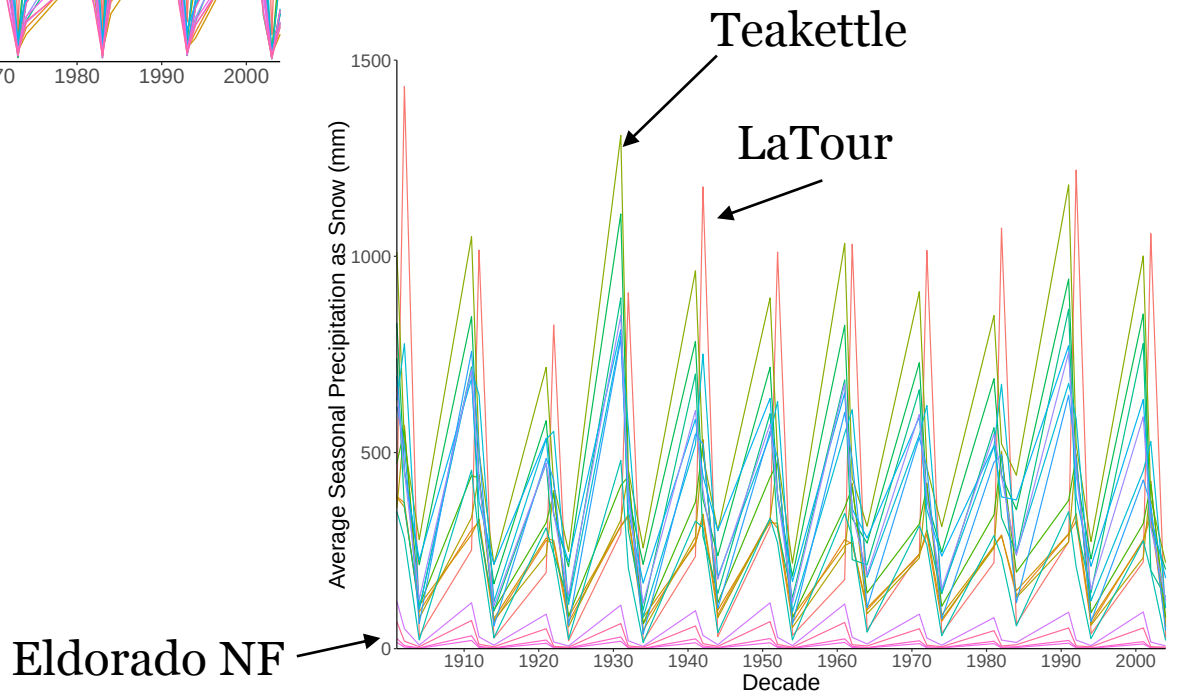
17 seed lots

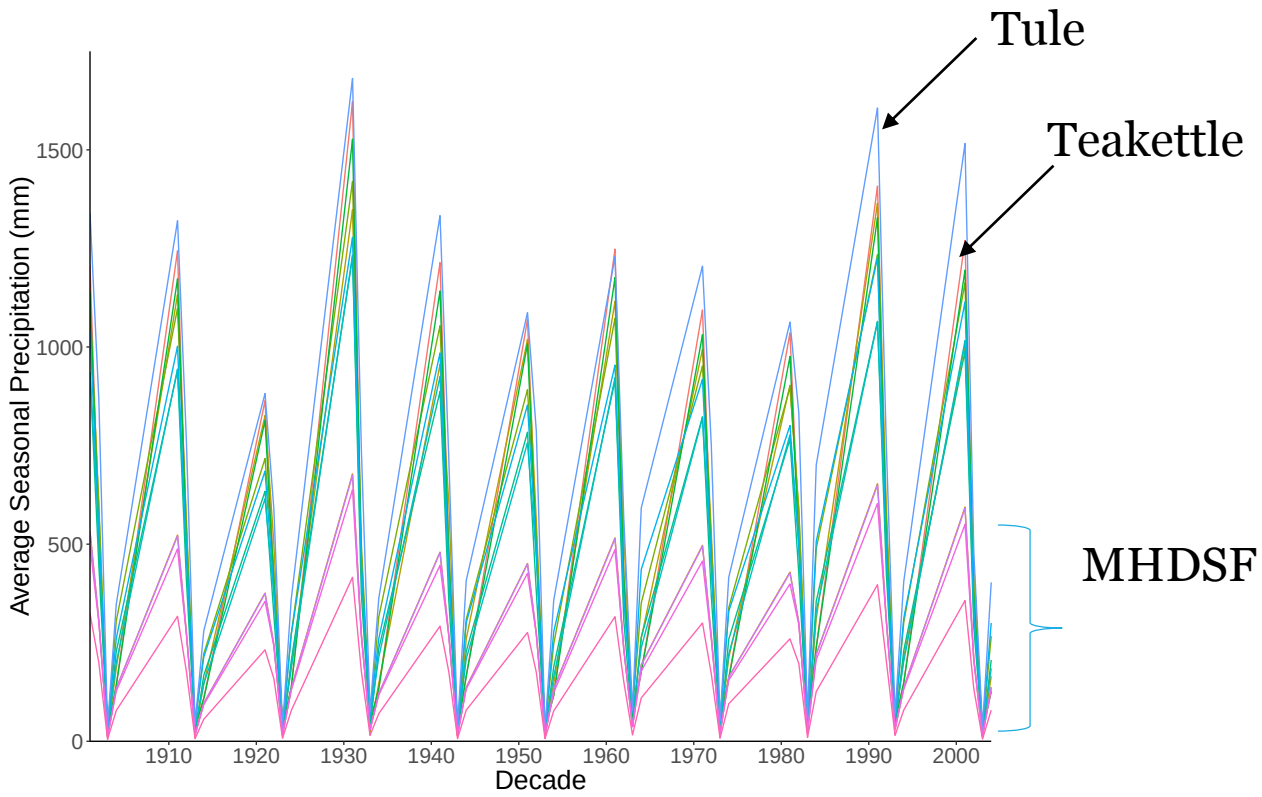


Coefficient of Variation

LaTour = 0.68
STEF = 0.75
MHDSF = 0.83

Species = 0.98





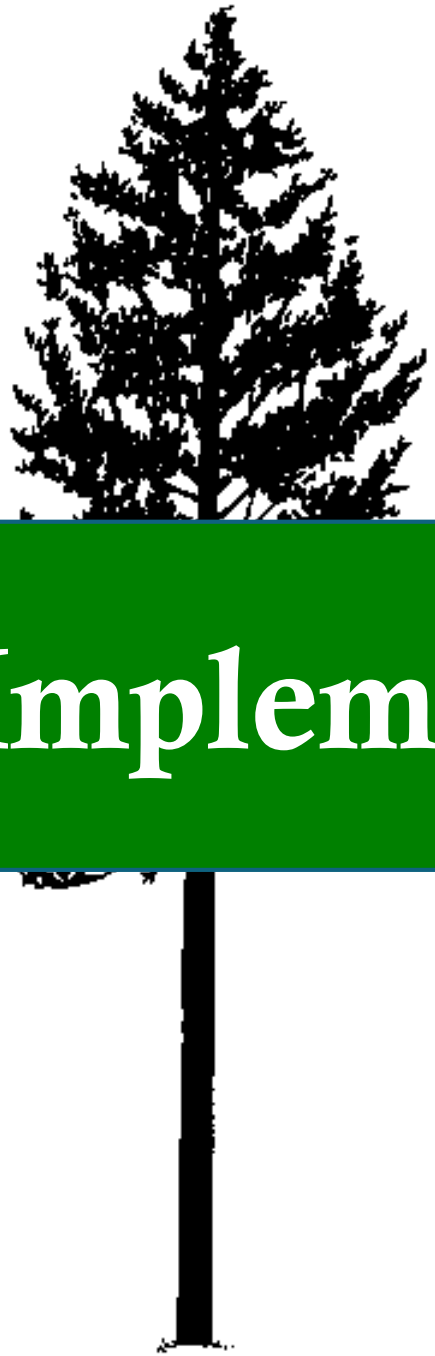
Sequoiadendron giganteum

12 seed lots

Coefficient of Variation

Tule = 0.78
MHDSF = 0.79
Teakettle = 1.00

Species = 0.97

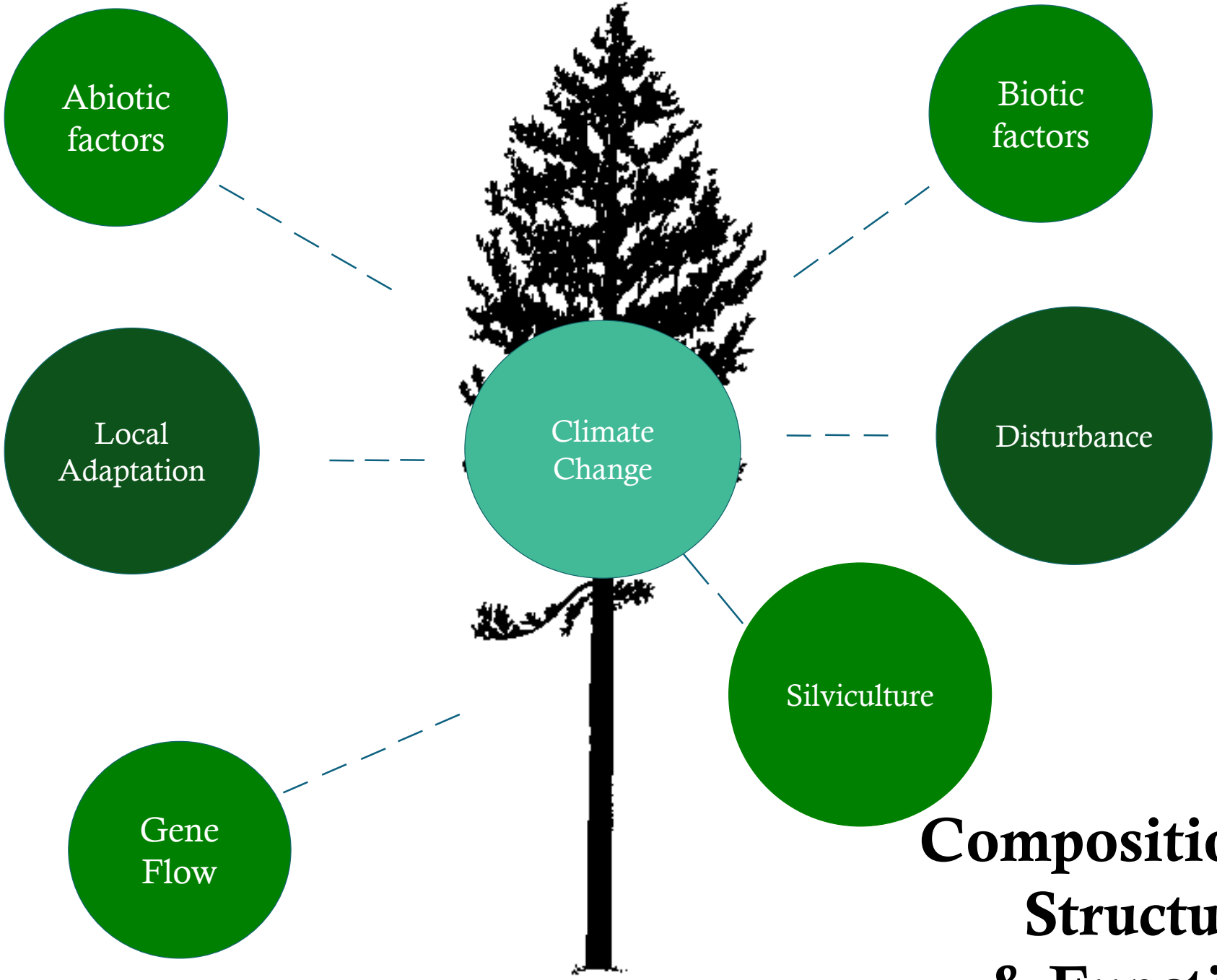


Project Implementation

Grouse Ridge (UC Berkeley)

Prescribed Burn Prep

Planting Site Prep


Abiotic factors
Biotic factors
Local Adaptation
Climate Change
Disturbance
Silviculture
Gene Flow
Composition, Structure, & Function

Discussion & Questions

Property	Ownership	Unit Elevation Range (ft)	Property Elevation Range (ft)	Latitude	Longitude	Seed Zone	PIPO	PSME	CADE	QUKE	ABCO	PILA	SEGI	PIJE	ABMA	PICO	TSME	PIMO
Core																		
LaTour Demonstration State Forest	Cal Fire	5200-5600	3800-6740	40° 38' 22"N	-121° 43' 26"W	522	X	o	X	o	X	X	o	o	o	X	o	X
Grouse Ridge	UC Berkeley	5200-6200		39° 22’ 23” N	-120° 39’17” W	525	X	o	X	x	X	X	planted	x	X	x		o
Mountain Home Demonstration State Forest	Cal Fire	6560-7400	4800-7600	36° 14' 24"N	-118° 40' 20"W	534	X	planted	X	X	X	X	X	o	o			
Companion																		
Stanislaus-Tuolumne Experimental Forest	USFS PSW	5200-6400	5200-6400	38° 11' 04"N	-120° 01' 01"W	531	X	x	X	X	X	X	planted	X	o	o	o	o
TeaKettle Experimental Forest	USFS PSW	6600-7500	6500-9200	36° 58' 00"N	-119° 01' 00"W	533			X	x	X	X		X	X	o		o

Mountain Home Total Basal Area (ft^2/acre) & Trees/Acre

Shake Unit

Block	Treatment	BA (ft^2/ac)	TPA
1	C	395	203
1	T	384	168
1	RE	281	180
1	RT	453	157
2	T	204	197
2	RT	295	247
2	C	455	150
2	RE	226	116
3	RE	407	100
3	RT	171	92
3	T	502	88
3	C	392	213

Cal Unit

Block	Treatment	BA (ft^2/ac)	TPA
1	RT	418	71
1	RE	168	95
1	T	678	123
1	C	272	84
2	RE	266	86
2	T	212	56
2	RT	306	127
2	C	299	70
3	RE	859	43
3	C	188	97
3	T	289	90
3	RT	273	133

Mountain Home - Shake Unit Basal Area (ft^2/acre) by Species

Block	Treatment	PIJE	PILA	CADE	PIPO	ABCO	ABMA	QUKE	SEGI
1	C	0	112	1	0	0	282	0	0
1	T	25	8	35	0	0	113	0	204
1	RE	2	14	5	0	1	155	0	102
1	RT	8	14	26	2	0	61	0	342
2	T	16	51	5	0	0	121	12	0
2	RT	0	91	66	4	0	132	0	0
2	C	0	5	100	0	0	149	0	200
2	RE	0	0	21	0	0	78	0	126
3	RE	0	7	0	0	0	199	0	184
3	RT	0	0	14	1	16	109	0	31
3	T	0	0	0	0	17	129	0	352
3	C	8	17	40	0	0	125	21	183

Mountain Home - Cal Unit Basal Area (ft^2/acre) by Species

Block	Treatment	PIJE	CADE	CONU	PILA	PIPO	ABMA	ABCO	PSME	SEGI
1	RT	0	4	0	10	0	0	75	0	328
1	RE	4	0	0	23	0	0	134	1	0
1	T	6	11	0	10	0	0	148	0	504
1	C	15	11	0	13	0	0	120	0	108
2	RE	0	0	0	21	0	39	98	0	109
2	T	0	0	0	0	0	0	83	0	129
2	RT	0	0	0	2	0	14	80	0	211
2	C	0	0	1	45	0	1	99	0	153
3	RE	5	0	0	2	0	0	44	0	805
3	C	21	14	0	0	0	0	119	0	33
3	T	0	45	0	10	0	0	55	0	162
3	RT	0	45	0	8	2	0	139	0	79