Fire and Fuels Feedbacks in Oak Woodland Ecosystems

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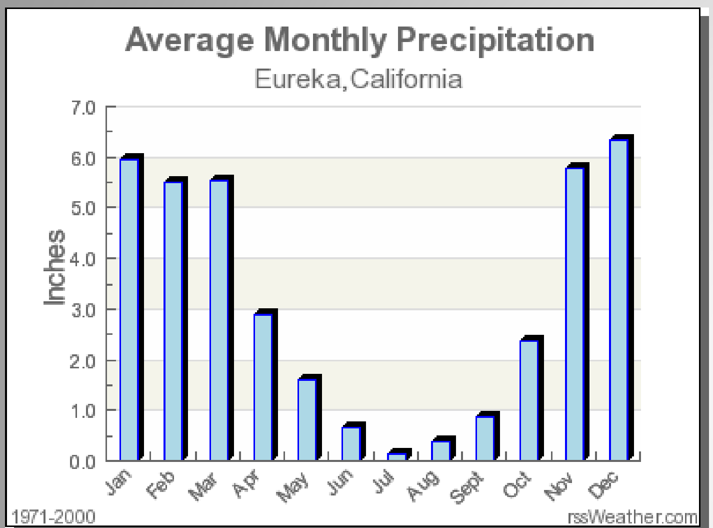
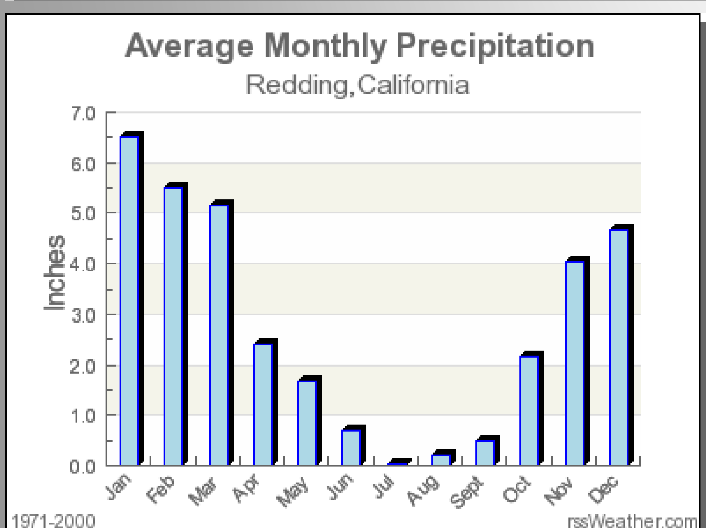
*Whiskeytown NRA
*Oregon Caves NM
*Six Rivers NF

November 12th 2015

Redwood NP

Whiskeytown NRA





Fire and Oaks widely studied

A meta-analysis of the **fire-oak** hypothesis: does prescribed burning promote **oak**reproduction in eastern North America?
PH Brose, DC Dey, RJ Phillips, TA Waldrop - Forest Science, 2013 - ingentaconnect.com

Fire and the development of **oak** forests
MD Abrams - BioScience, 1992 – JSTOR

A 400-year history of **fire** and **oak** recruitment in an old-growth **oak** forest in western Maryland, USA
DL Shumway, MD Abrams... - Canadian Journal of ..., 2001 - NRC Research Press

Prescribed **fire** in North American forests and woodlands: history, current practice, and challenges
KC Ryan, EE Knapp, JM Varner - ... in **Ecology** and the Environment, 2013 - Eco Soc America

Long-term effects of **fire** severity on **oak**-conifer dynamics in the southern Cascades
MI Cocking, JM Varner, EE Knapp - **Ecological** Applications, 2014 - Eco Soc America

Fire effects on **Gambel oak** in **southwestern** ponderosa pine-**oak** forests
SR Abella, PZ Fulé - 2008 - digitalscholarship.unlv.edu

Fire-related recruitment in stagnant Quercus douglasii populations
MP McClaran, JW Bartolome - Canadian Journal of Forest ..., 1989 - NRC Research Press

Fire effects on prairies and **oak** woodlands on **Fort Lewis**, Washington
RK Tveten, RW Fonda - 1999 - research.wsulibs.wsu.edu

Predicting Douglas-fir Sapling **Mortality** Following Prescribed **Fire** in an Encroached Grassland
EA **Engber**, JM **Varner** - **Restoration Ecology**, 2012 - Wiley Online Library

The burning characteristics of southeastern oaks: discriminating **fire facilitators** from **fire impeders**
JM **Kane**, JM Varner, JK Hiers - Forest Ecology and Management, 2008 - Elsevier

Patterns of flammability of the California oaks: the role of leaf traits
EA Engber, JM Varner III - Canadian Journal of Forest ..., 2012 - NRC Research Press

Fire and Fuels Feedbacks in Oak Woodland Ecosystems

- **Fuelbed properties and enhanced flammability**
  - **Fine fuel – the value of grass**
  - **Leaf litter flammability in CA oaks**

- **Restoration thresholds**
  - **Fire vs Mechanical**
  - **Tree mortality in low/high severity scenarios**

Conifer Encroachment Alters Fuelbed Properties

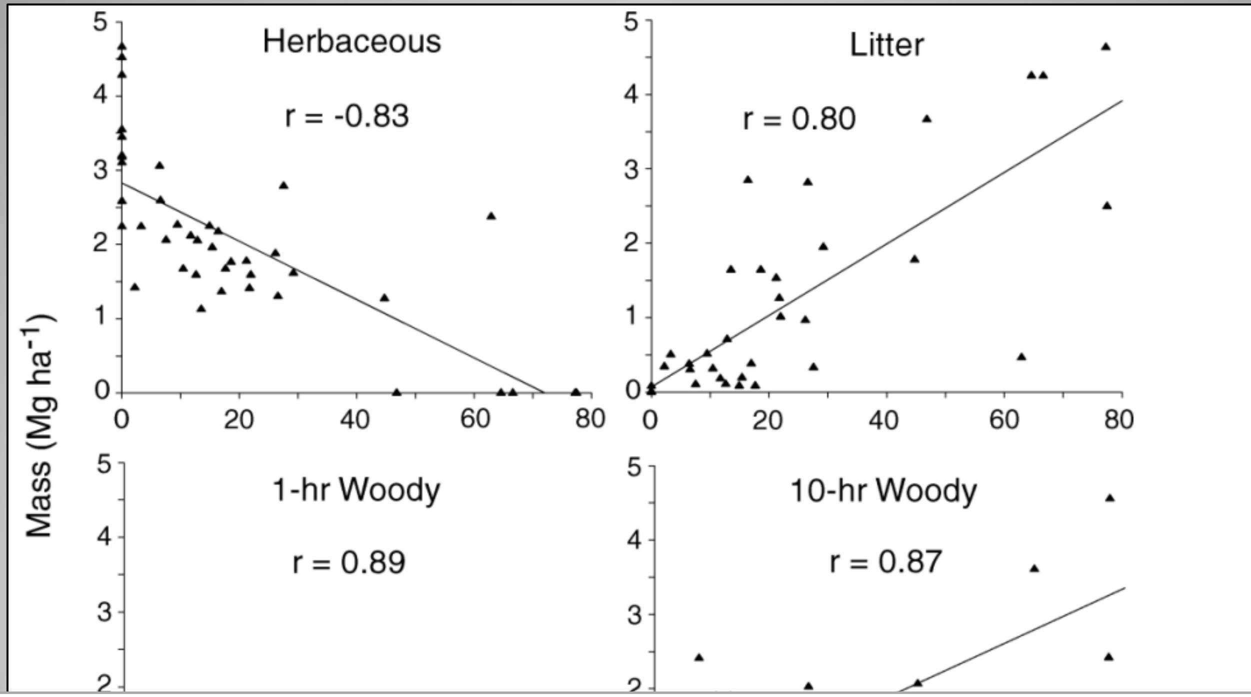
Fuelbed properties and conifer encroachment

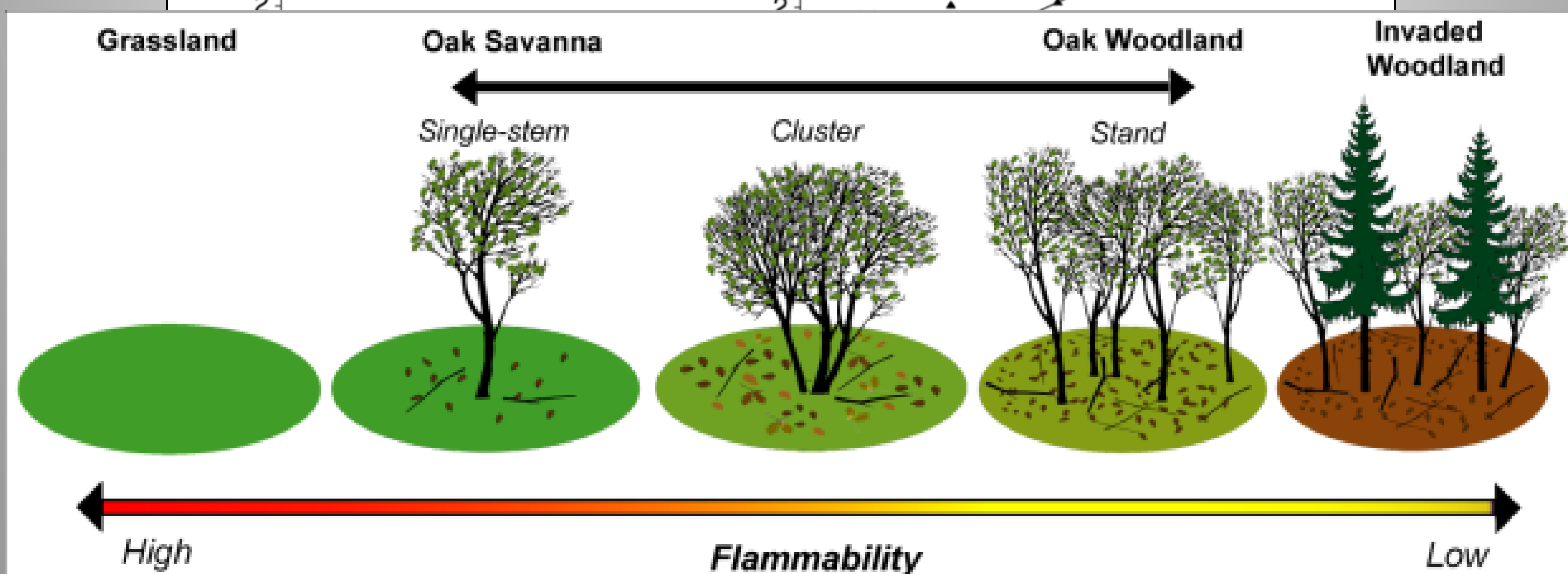
•***Fuelbed Properties: woodland fuels are flammable***

- •Fuels: load, size class, arrangement, depth, connectivity
- •Moisture content: live and dead
- •Bulk Density

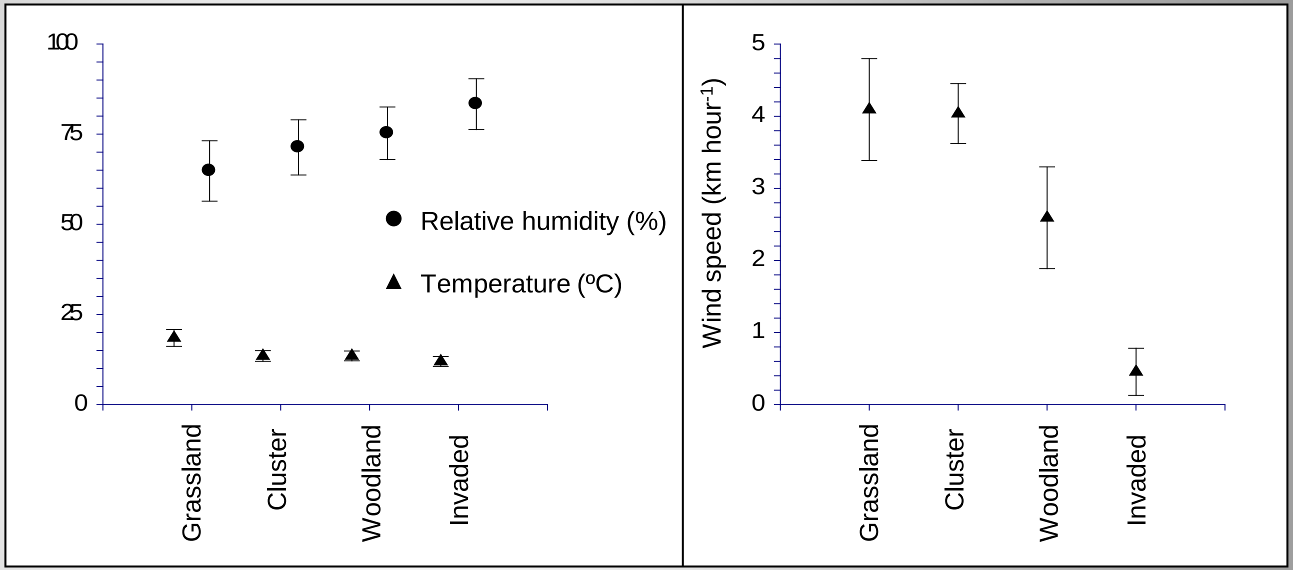
•Flammability or Pyrogenicity
- •Fire Regime
- •Burn Window

Loss of fine herbaceous fuel and biodiversity





Changes in microclimate and fuel moisture



Unencroached, native understory

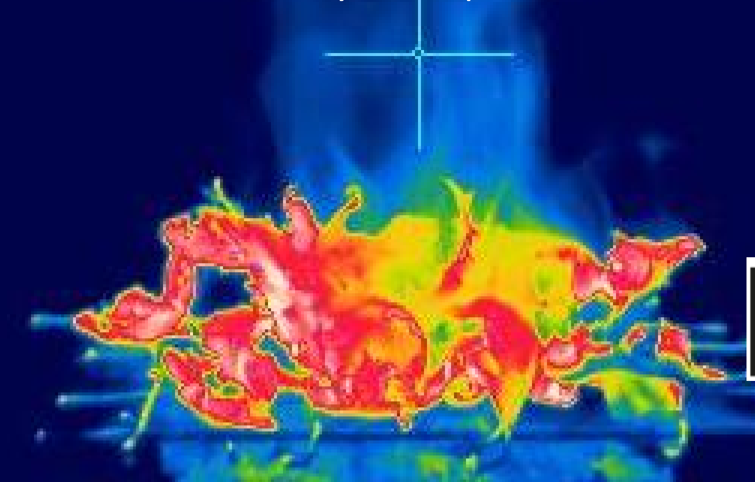
Overtopped, native understory not present

M. Cocking Photos

Characteristics of leaf litter flammability in the California oaks

Eamon Engber and J. Morgan Varner

Wildland Fire Laboratory, Department of Forestry & Wildland Resources
Humboldt State University, 1 Harpst Street, Arcata, CA 95521



Patterns of flammability of the California oaks: the role of leaf traits

Eamon A. Engber and J. Morgan Varner, III

Can. J. For. Res. 42: 1965–1975 (2012)

HUMBOLDT STATE UNIVERSITY Wildland Fire Laboratory

- Why flammability?
  - Evolved trait (Mutch, 1970; Fonda, 2001; Schwilk, 2003)
  - Fire regime/fire life history strategy (Fonda et al., 1998; Fonda, 2001)
  - Ecological position within fire prone landscapes (Kane et al., 2008)
- Why California oaks?
  - *Quercus* diversity (20 + species)
  - Variety of leaf morphologies
  - Lots of fire

Litter Collection Sites

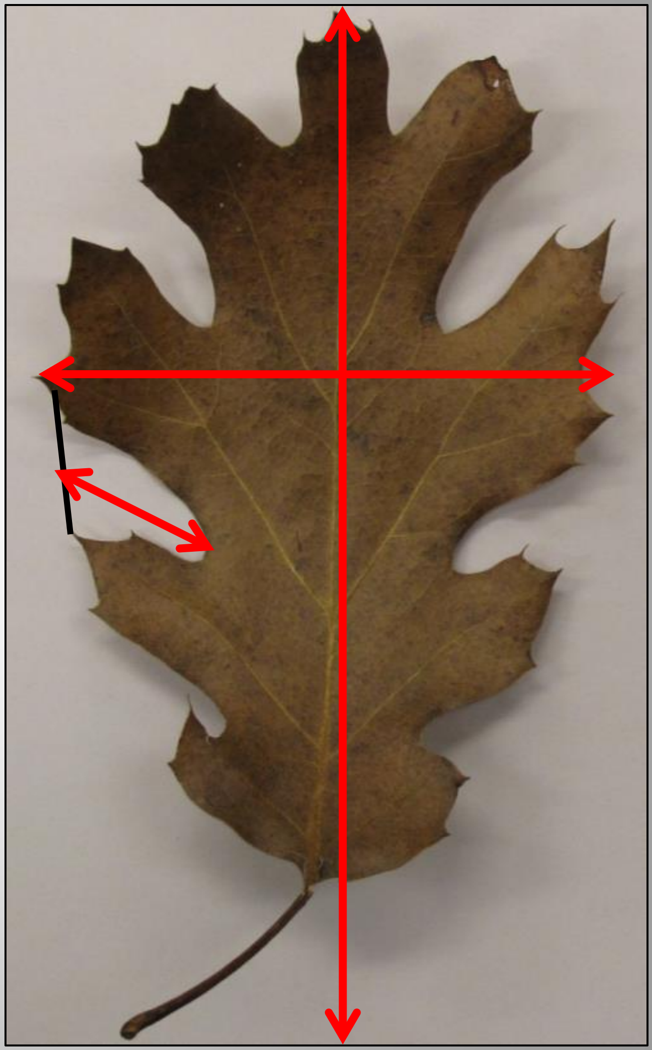
Methods

- Standard burning protocol (Fonda, 2001)
  - 15 g leaves dried at 40° C for 24 hrs

- 35 x 35 cm grid of 8 xylene-soaked cotton strings
- Fuelbed depth: 4 points 7 cm from corners
- 119 burn trials (7 reps per species)

Methods

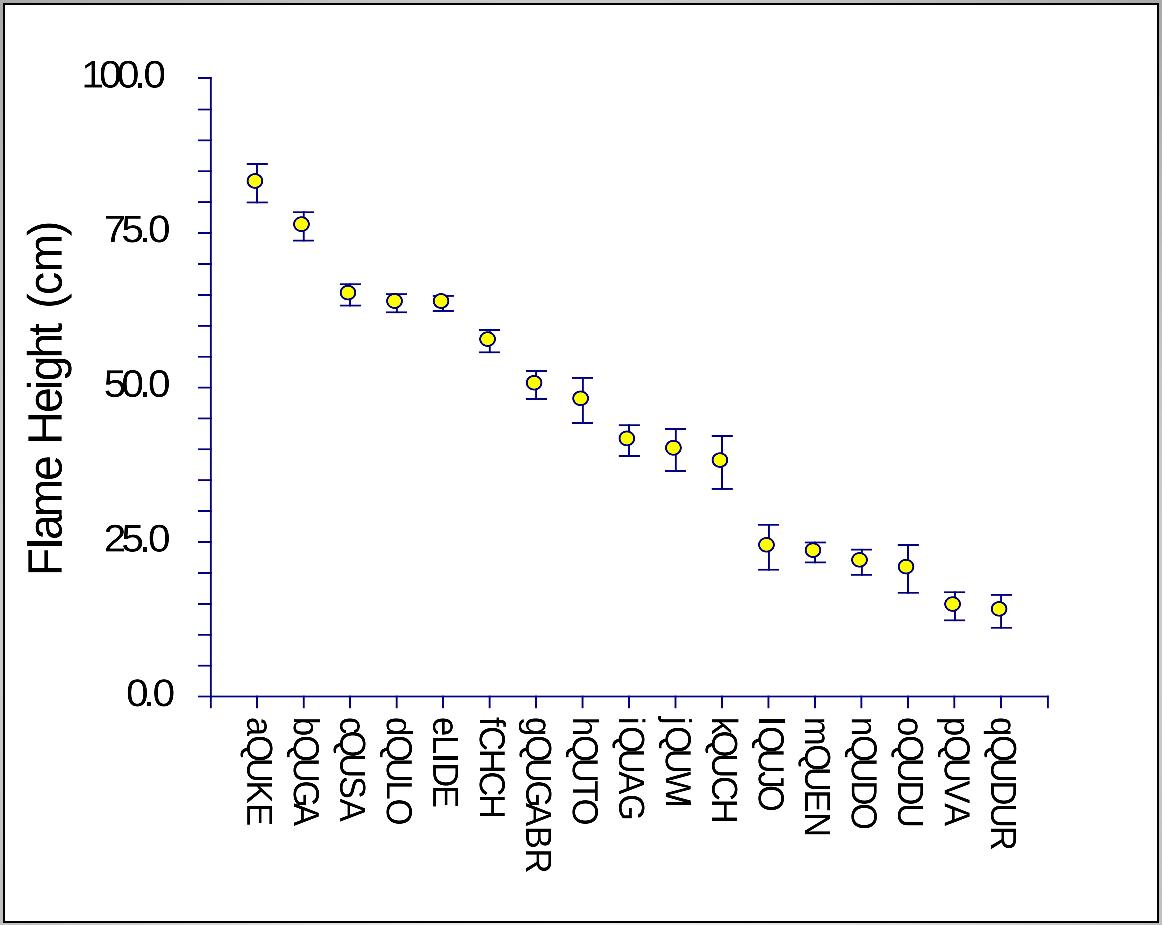
- 15 Leaf Characteristics
  - Curled length, height, width
  - Flat length, width
  - Leaf thickness: edge, middle
  - Sinus depth
  - Surface area
  - Volume
  - Surface area:volume
  - Perimeter
  - Perimeter:area
  - Weight
  - Weight:volume



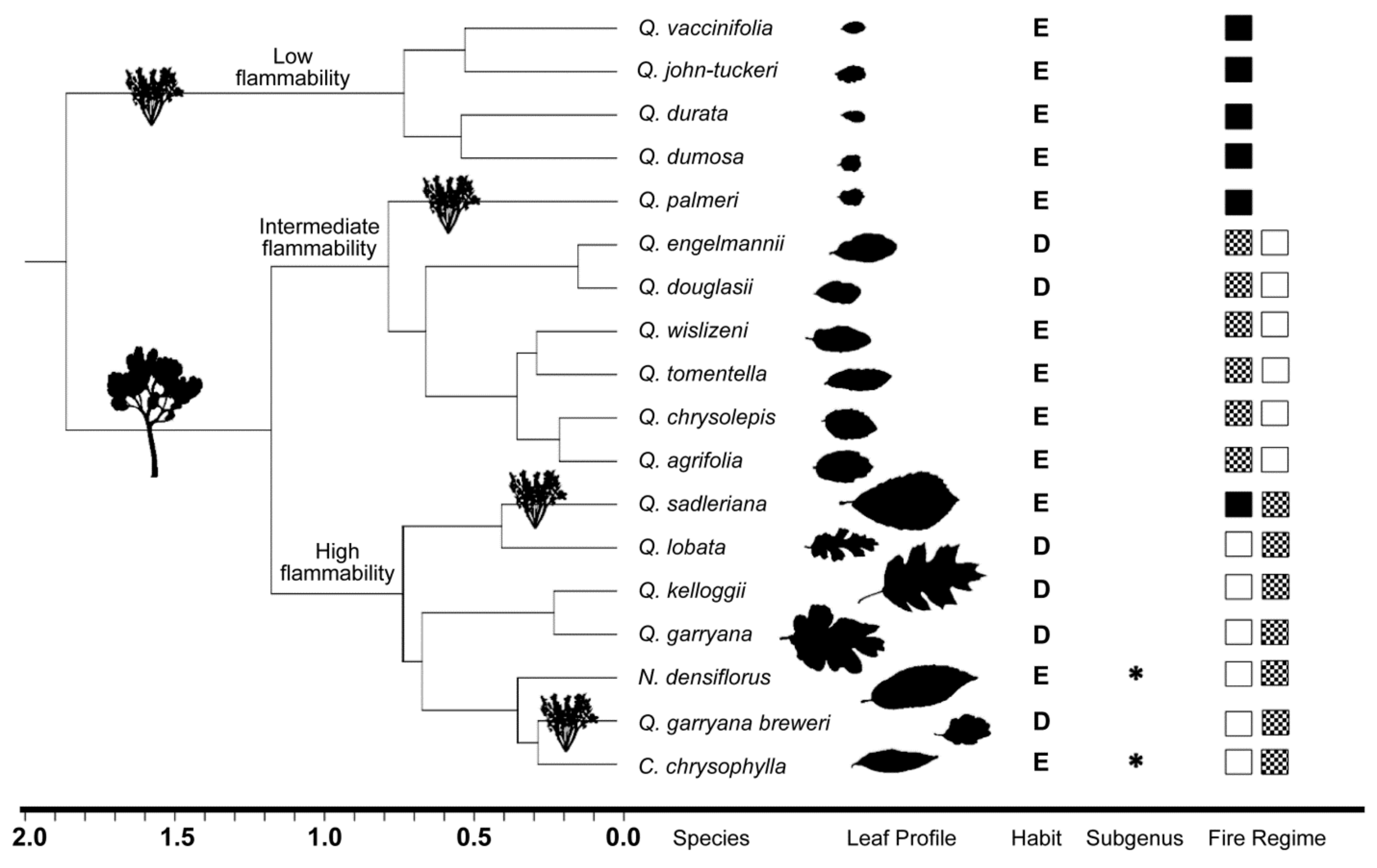
Methods

- Flammability metrics
  - Flame height (cm)________**Intensity**
  - Flame time (sec)__________**Sustainability**
  - Smolder time (sec)_________**Sustainability**
  - Percent consumption (%)___**Consumability**

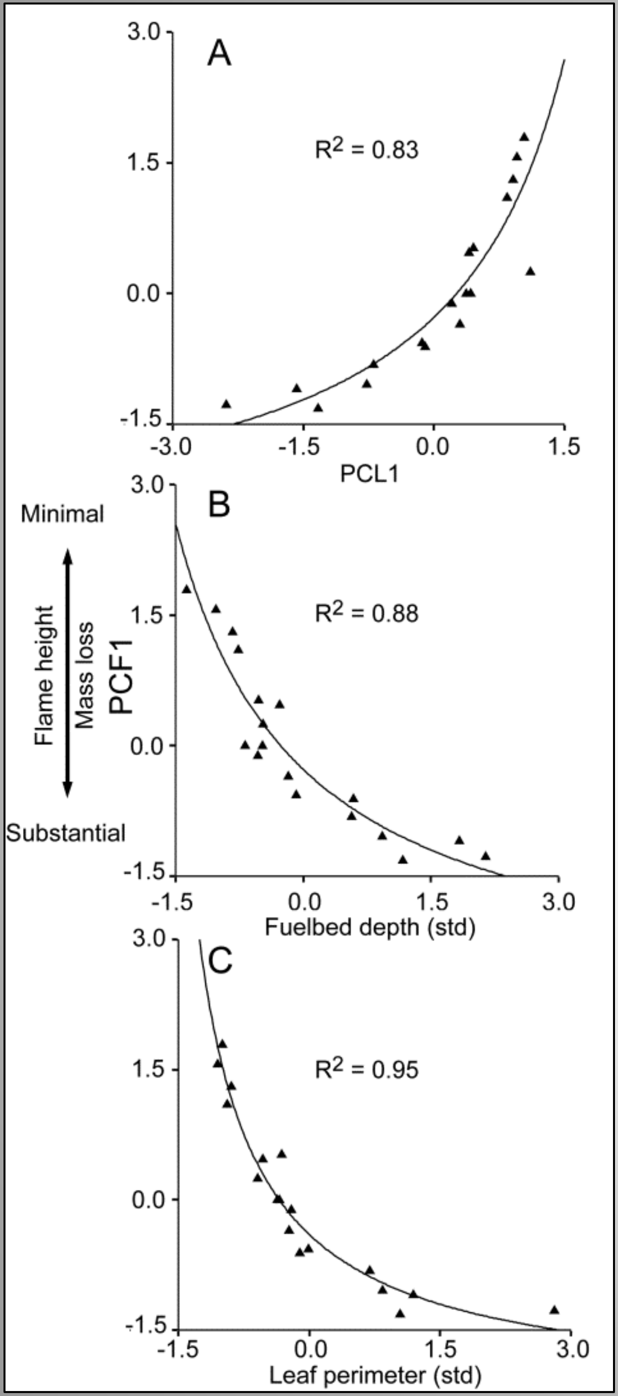
CA black oak & Oregon white oak



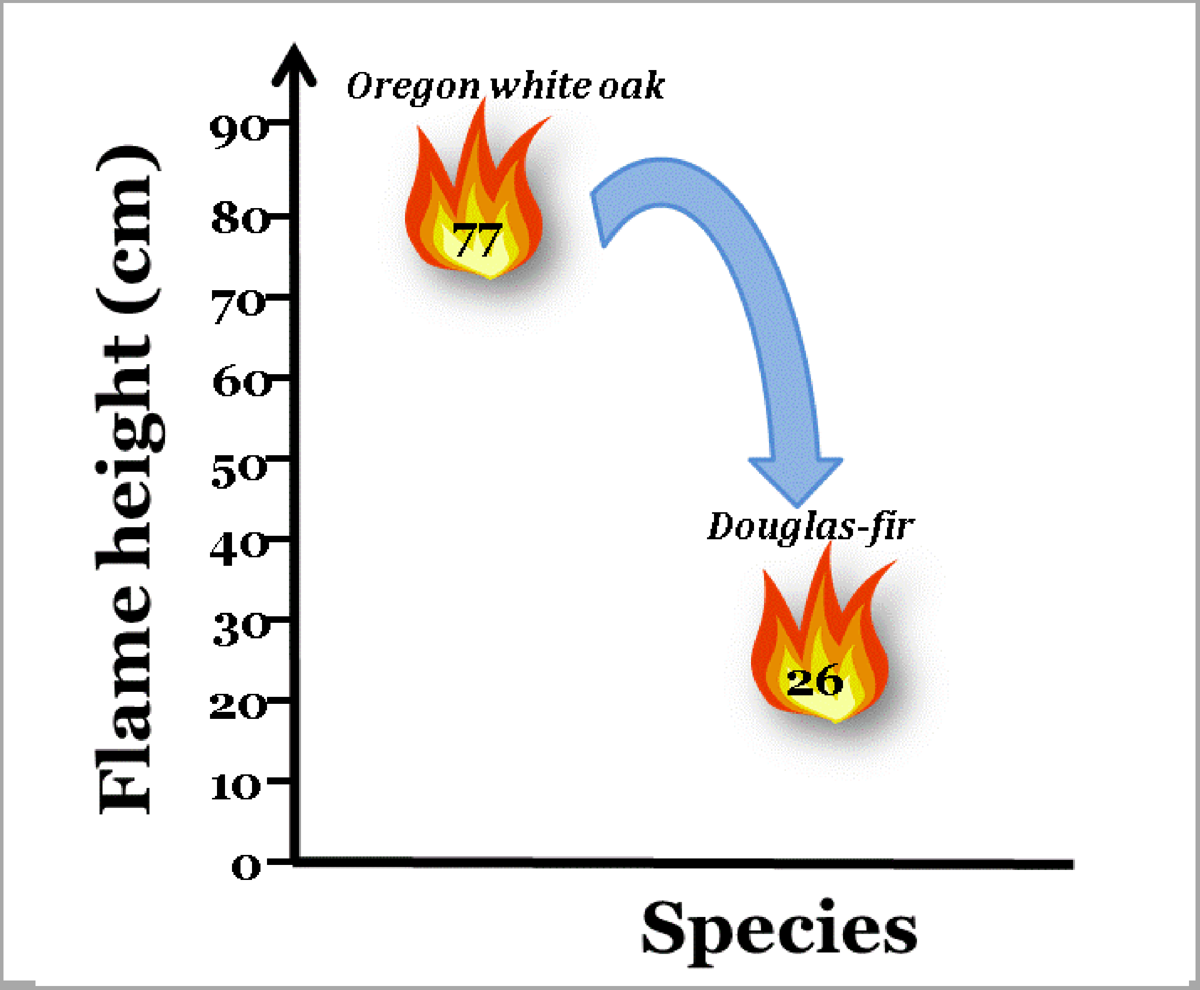
Three flammability clusters

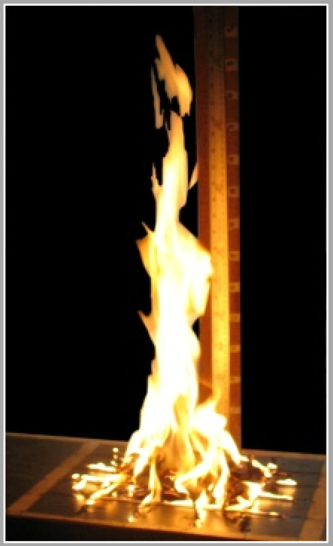


Leaf Size (perimeter) and fuelbed depth



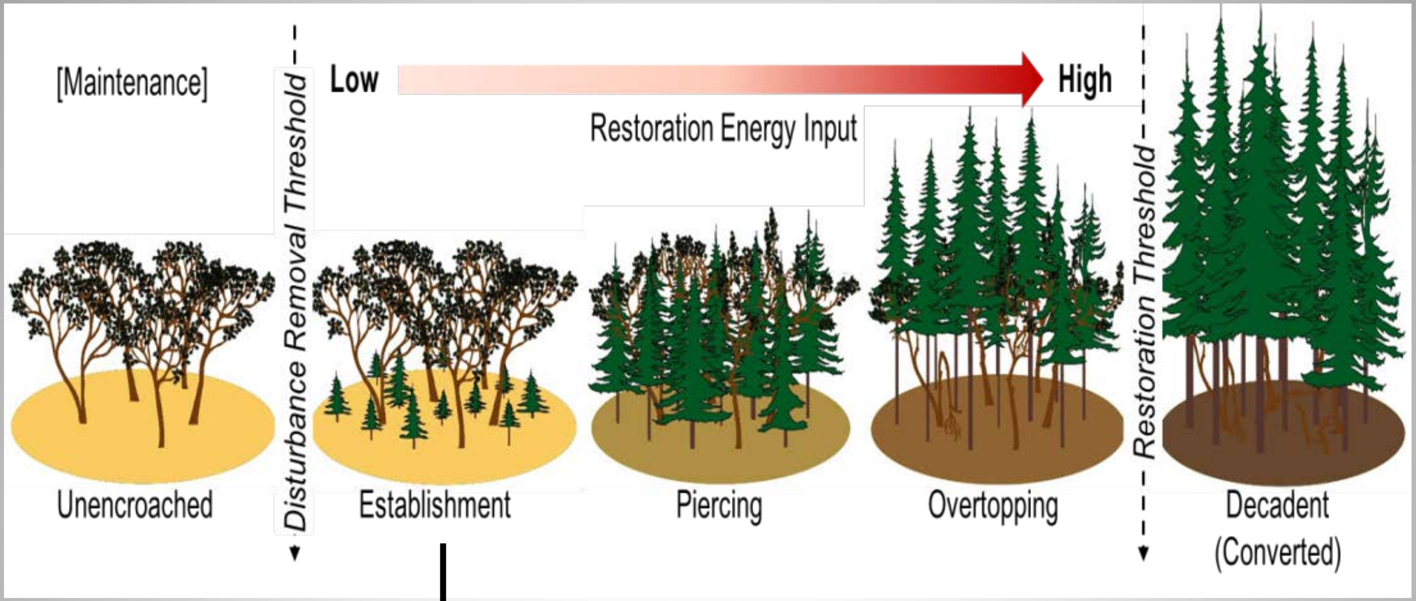
Oak litter v. invading conifers





Engber & Varner 2012 CJFR

Restoration Feasibility Thresholds



Intact
Disturbance
Regime

Rx Fire
or
Wildfire
(5 yr interval)

Cocking, Varner, & Engber 2014

Redwood NP Bald Hills Oak Woodlands
Maintenance with Rx Fire

Maintenance with Rx Fire

Maintenance with Rx Fire

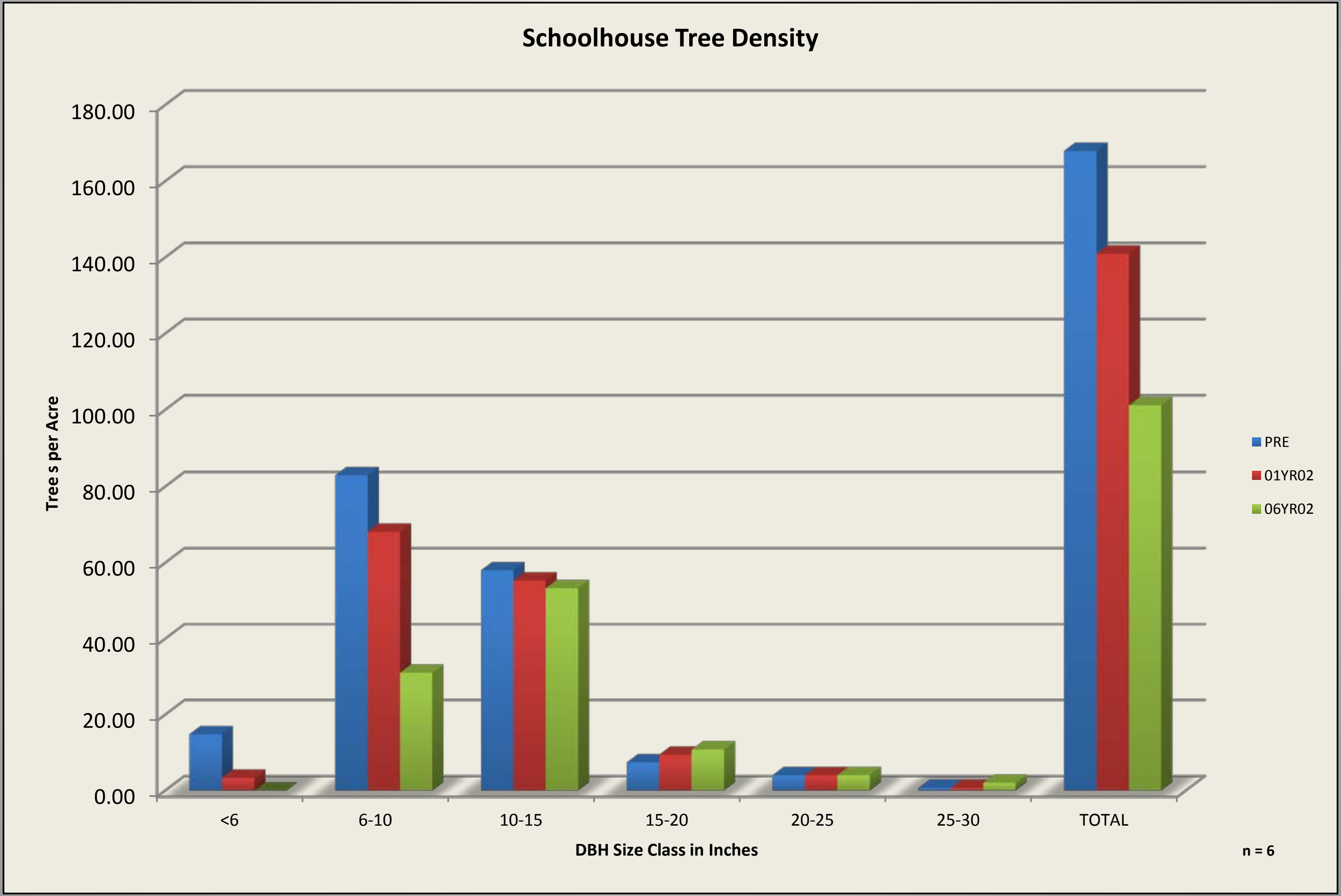
Eastside Rx Burn October 2013

Maintenance with Rx Fire

Eastside Rx Burn October 2013

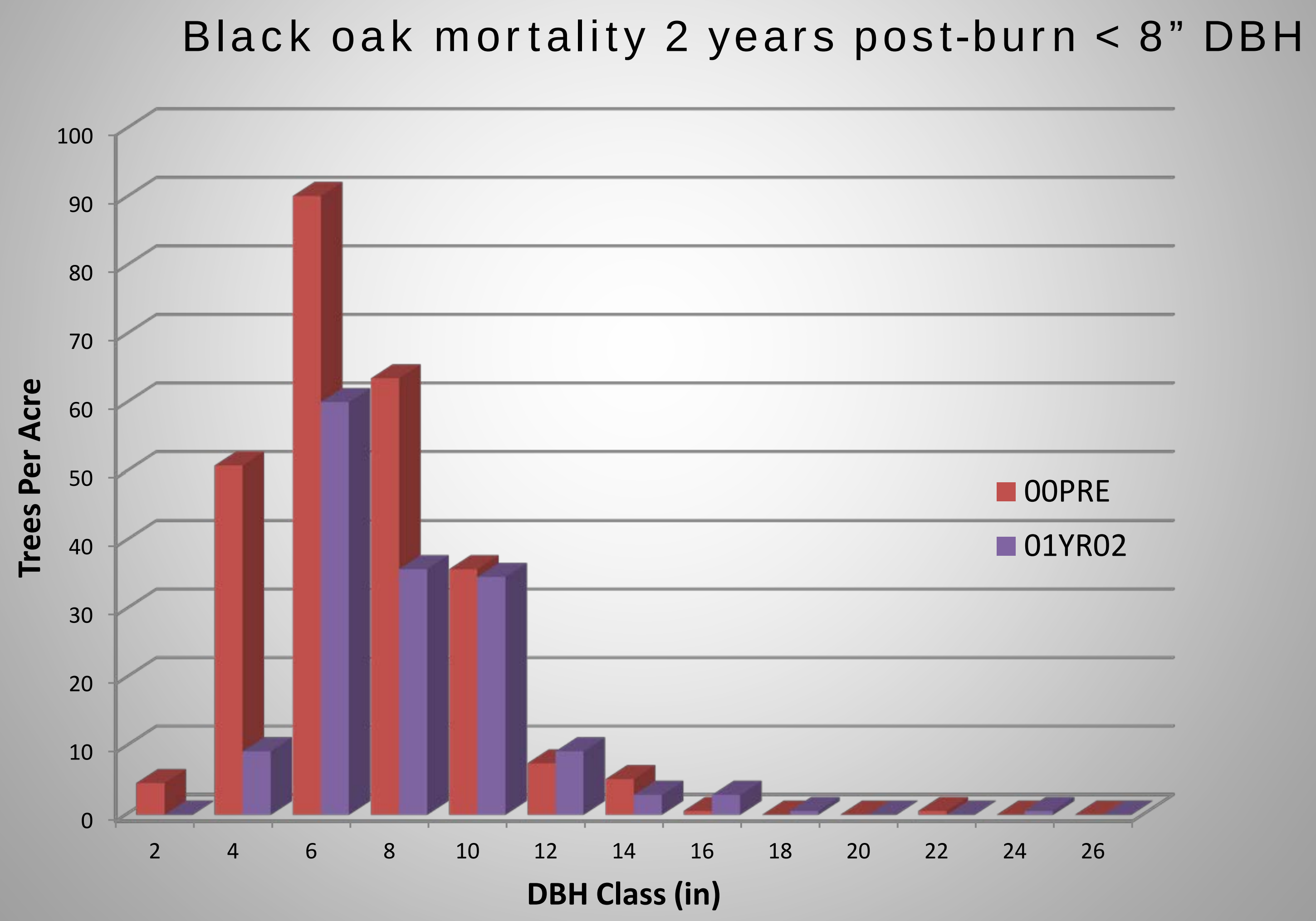
Maintenance with Rx Fire

- *Some white oak mortality < 10" DBH*



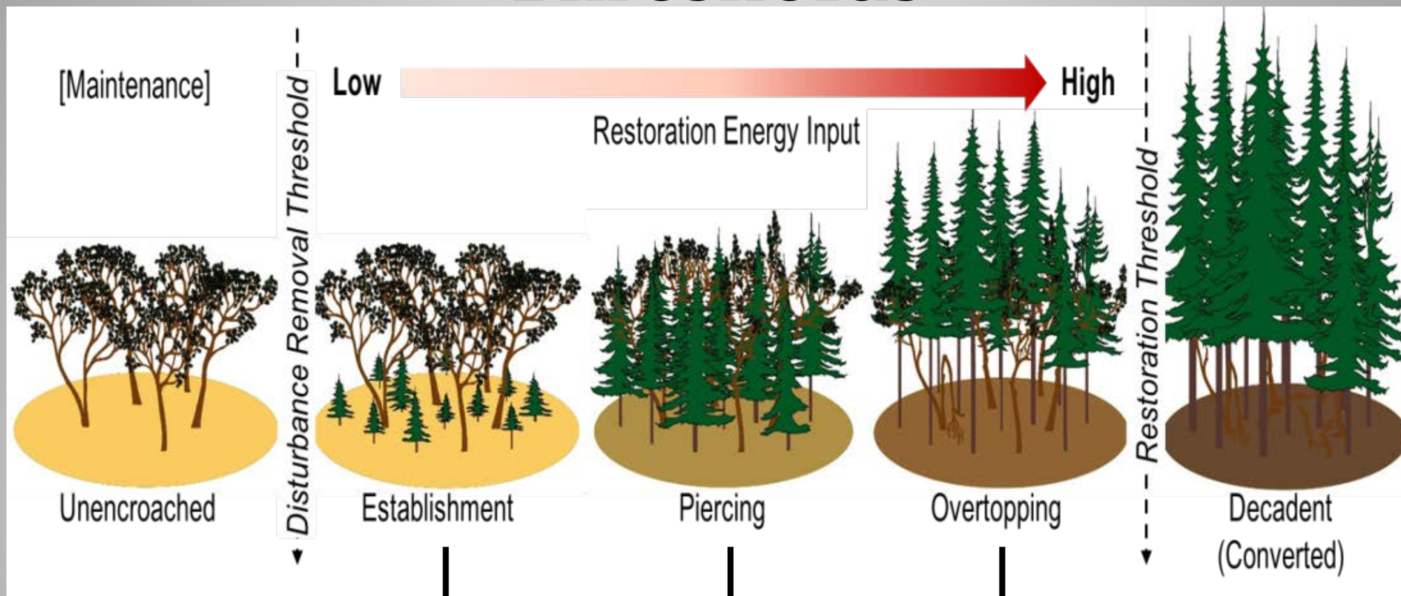
Maintenance with Rx Fire

- *Whiskeytown NRA black oak*



Mechanical alternative in heavily encroached stands

Restoration Feasibility Thresholds



Intact Disturbance Regime

Rx Fire
or
Wildfire

Hand/mechanical treatments
or
High-severity fire

Mechanical treatments
or
High-severity fire

Establishes sprout stand
(Cocking *et al*. 2014)

Cocking, Varner, & Engber 2014

Findings from Lassen

Cocking et al. 2014

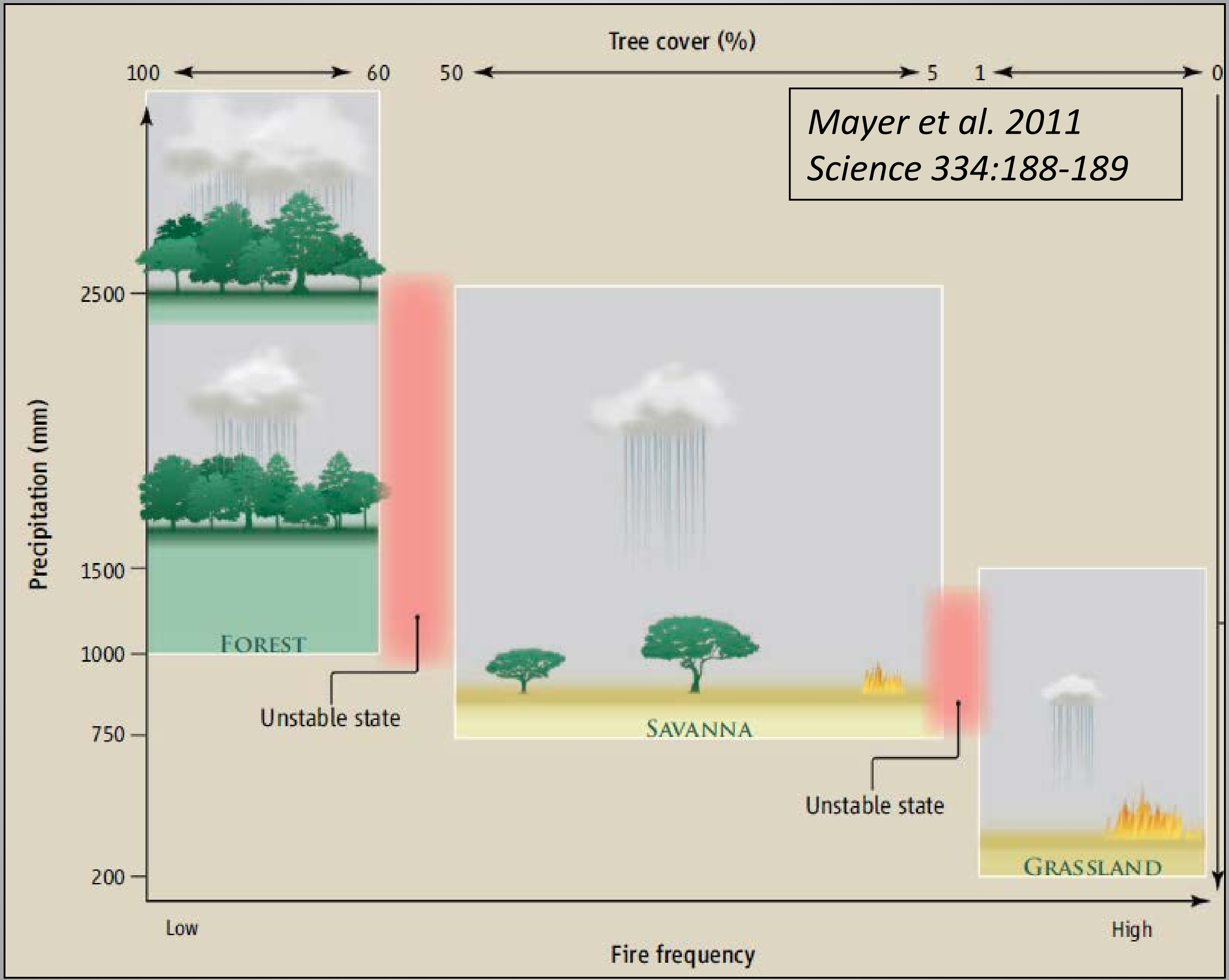
Compositional Change with Fire Severity: 10 years

Low severity = maintained fir dominance

High severity = increased oak dominance

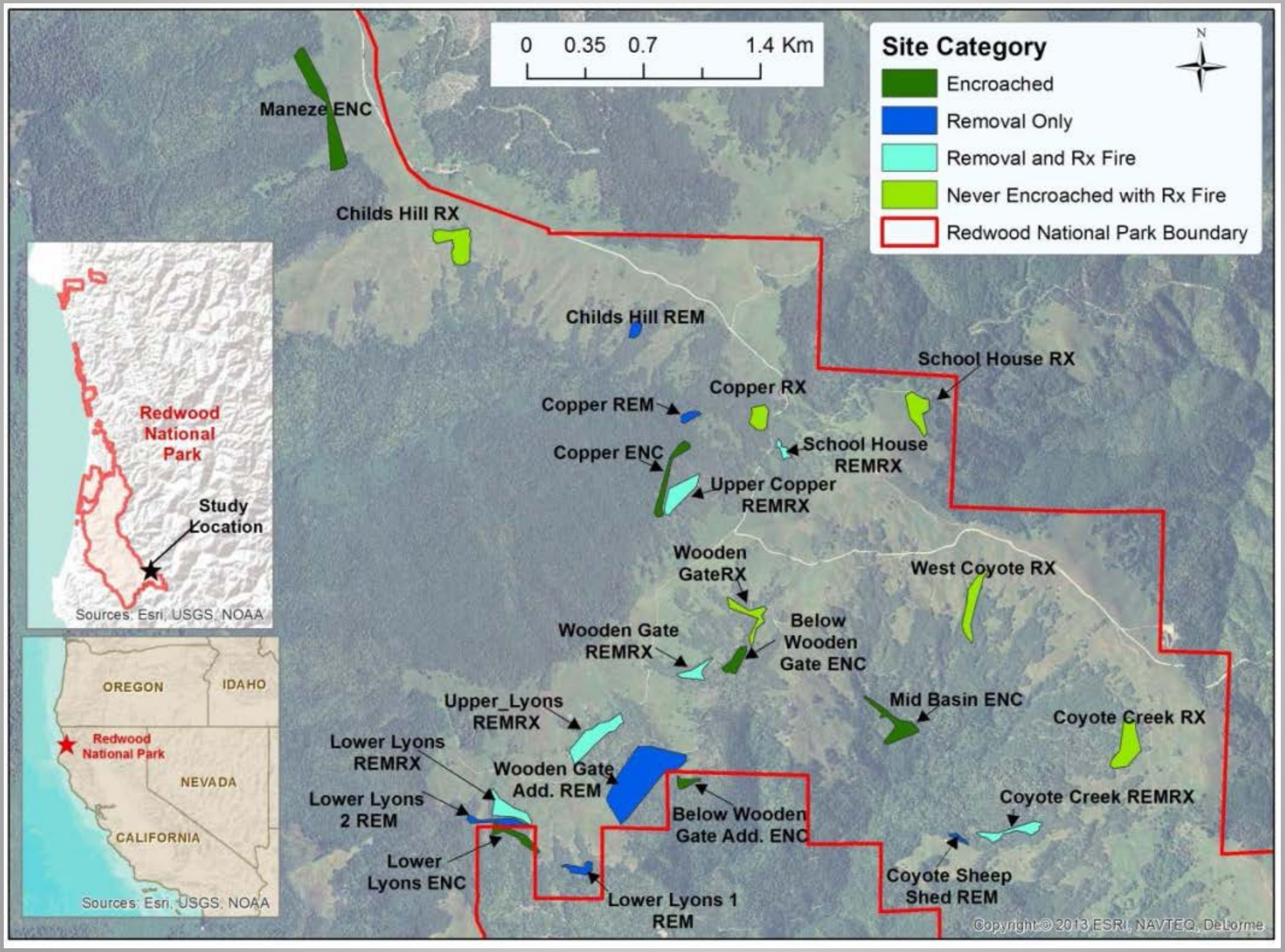
THANKS!

Fire important in savannas globally



•Positive feedbacks: veg. > fuels > fire regime

Non-Native Spp vs. Functional Communities



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Native Species Richness

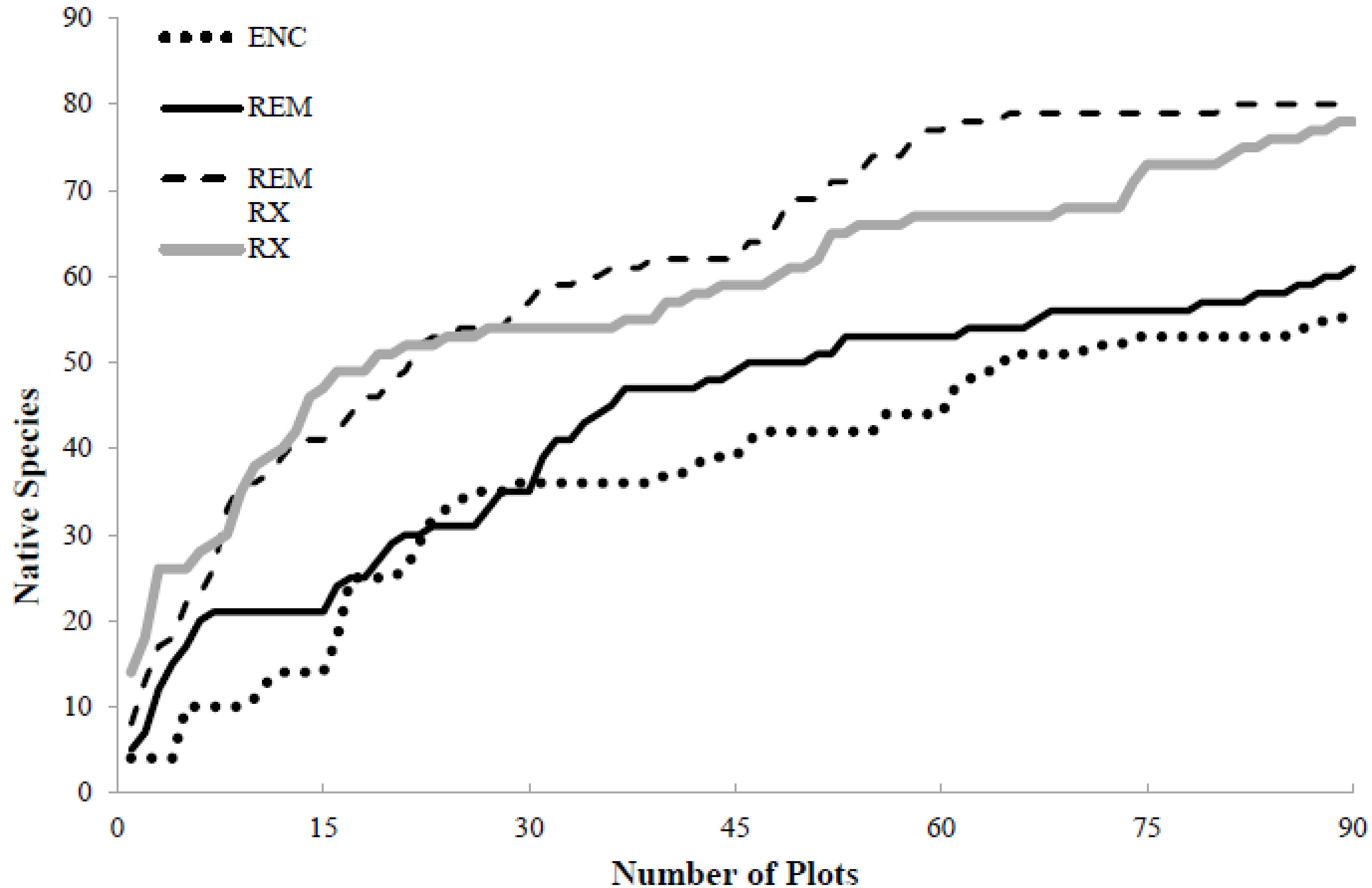

Figure 3. Native species richness in Bald Hills woodland sites combined by treatment category. ENC = encroached woodlands; REM = woodlands with conifer removal only; REMRX = woodlands with conifer removal and prescribed fire; RX = intact burned woodlands.

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Understory Species Richness

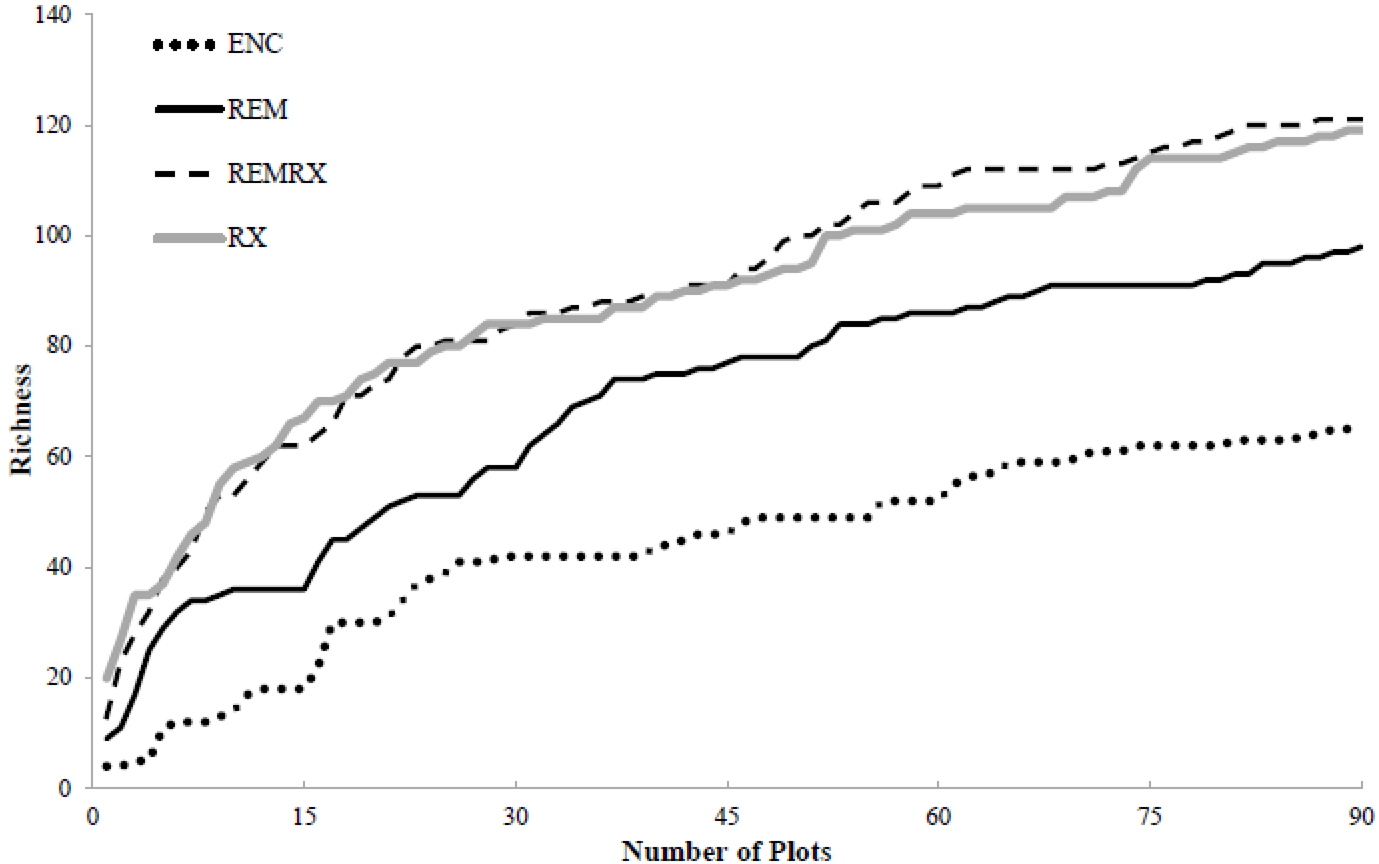

Figure 4. Species richness in Bald Hills woodland sites combined by treatment category. ENC = encroached woodlands; REM = woodlands with conifer removal only; REMRX = woodlands with conifer removal and prescribed fire; RX = intact burned woodlands.

Cover Variable	ENC	REM	REMRX	RX	ANOVA p-value	K-W p-value
Absolute Total	25.2 (9.6)[b]	51.5 (5.2)[ab]	68.5 (5.1)[a]	59.9 (6.6)[a]	< **0.01**	
Absolute Native	24.9 (9.6)	36.2 (7.1)	45 (6.4)	33.1 (6.9)	0.340	
Absolute Non-native	0.2 (0.1)[b]	14.3 (3.3)[ab]	23.3 (4.4)[a]	26.5 (2.1)[a]		< **0.01**
Absolute Native Forb	11 (0.3)	14.1 (2.6)	19.9 (0.3)	15.3 (0.2)		0.140
Absolute Non-native Forb	0.1 (0.04)[b]	4.7 (1.2)[ab]	7.2 (1.6)[a]	5.3 (0.7)[a]		< **0.01**
Absolute Native Grass	0.6 (0.2)[b]	1.5 (0.3)[ab]	6.1 (4.0)[a]	5.6 (2.3)[a]	< **0.01**	
Absolute Non-native Grass	0.07 (0.1)[b]	9.6 (2.2)[ab]	16.2 (2.9)[a]	21.2 (1.8)[a]		< **0.001**
Absolute Native Fern	4 (2.6)	2.6 (1.7)	3.1 (2.2)	0.8 (0.5)	0.701	
Absolute Native Shrubs	7.8 (3.0)	15.5 (6.0)	13 (4.1)	7 (4.1)	0.290	
Absolute Non-native Shrubs	0 (0.0)	0 (0.0)	0.006 (0.0)	0 (0.0)		0.392
Absolute Native Tree	1.5 (0.8)	2.5 (0.9)	2.8 (0.7)	4.4 (1.2)	0.196	
Absolute Native Annual Grasses	0 (0.0)	0 (0.0)	0 (0.0)	0.006 (0.0)		0.390
Absolute Non-native Annual Grasses	0.01 (0.0)[b]	5.8 (1.2)[a]	9.3 (2.1)[a]	9 (1.7)[a]	< **0.001**	
Absolute Native Perennial Grasses	0.6 (0.2)[b]	1.5 (0.3)[ab]	6.1 (4.0)[a]	5.6 (2.3)[a]	< **0.01**	
Absolute Non-native Perennial Grasses	0.06 (0.0)[b]	3.8 (1.1)[ab]	6.9 (3.6)[ab]	12.0 (2.6)[a]		< **0.001**
Absolute Native Perennial Forbs	9.6 (5.2)	9.4 (1.8)	17.9 (3.1)	13.8 (2.2)		0.070
Absolute Non-native Perennial Forbs	0.0 (0.0)[b]	3.1 (0.9)[a]	3.6 (0.9)[a]	2.8 (1.0)[ab]		< **0.01**
Absolute Native Annual/Biennial Forbs	0.8 (0.3)	3.8 (2.6)	0.9 (0.3)	0.6 (0.2)		0.570
Absolute Non-native Annual/Biennial Forbs	0.1 (0.04)[b]	1.6 (0.5)[a]	3.6 (0.7)[a]	2.5 (0.5)[a]	< **0.01**	

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