The impact of invasive forbs on fuel loads in degraded coastal sage scrub

Joshua J. Paolini[1], Lauren H. Quon[1,2], and Erin J. Questad[1]

[1]Dept. of Biological Sciences; Cal Poly – Pomona; [2]Klamath Falls BLM

Introduction

- Invasive plant species can cause changes in fuel properties such as fuel load and fuel continuity, leading to changes in fire frequency, intensity, extent, type, and seasonality (*1*).
- Coastal sage scrub is a fire-adapted plant community that is experiencing widespread degradation due to direct anthropogenic activities, climate change, nitrogen deposition, and invasion of Eurasian forbs and grasses (*2,3, 4*).
- The spread of invasive grasses and forbs cause an increase in fine fuels that are available to burn during fire, yielding higher intensity burns that can lead to a type-conversion to invasive grasslands (*5*).
- Two factors that influence fine fuels are: 1) the abundance in the community of these species, and 2) their traits associated with resource acquisition, dispersal, and flammability (*6*).
- We measured the fine fuels of the five most common native species and the two most common invasive species, *Hirschfeldia incana* and *Centaurea melitensis*. We predicted that these two species contributed significantly to fine fuels, perhaps even exceeding the native species.
- In order to determine the underlying causes, functional traits that are associated with potential relative growth rate, leaf lifespan, and flammability were measured.
- In order to test if the most abundant species in the community inherently contributes the most to fine fuels, we measured the abundance of each species in the community.

Methods

<u>Invasive Species</u>
- *Hirschfeldia incana*
- *Centaurea melitensis*

<u>Native Species</u>
- *Eriogonum fasciculatum*
- *Artemisia californica*
- *Acmispon glaber*
- *Salvia mellifera*
- *Salvia apiana*

<u>Location</u>:

The Voorhis Ecological Reserve, Cal Poly Pomona, California, in Los Angeles Co.

<u>Functional Traits Measured:</u>
- Specific leaf mass (SLM) – May 2012
- Leaf dry matter content (LDMC) – May 2012
- Twig dry matter content (TDMC) – May/Aug. 2012
- Twig drying time (TDT) – May/Aug. 2012
- Degrees of ramification (DofR)

<u>Fuel:</u>
- fallen litter and individual biomass – October/November 2012

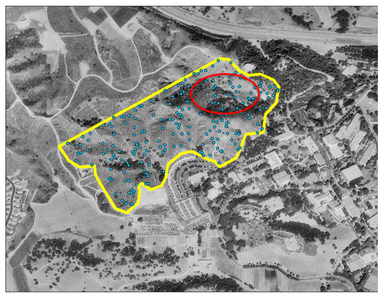
<u>Species Abundance Sampling and Fine Fuels:</u>
- Abundance estimated using 72 1 x 1 meter quadrat samples. Percent cover was estimated visually; individuals per m^2 counted – May/June 2013.
- For native species, fine fuels were estimated as follows: fine fuels (kg) = fallen litter (kg/m^2) x % cover x total area of reserve (m^2).
- For invasive species: fine fuels (kg) = # individuals/m^2 x grams of dead litter/individual x total area of reserve (m^2).

Results

- All native species exhibit traits that are associated with high flammability.
- Of the species examined, *Eriogonum fasciculatum* possess the greatest SLM, LDMC, TDMC, and relatively high DofR, indicating that this species has a low potential relative growth rate, long leaf lifespans, and relatively tough leaves
- The leaves of *Artemisia californica* were so small that the leaf area meter was unable to register them effectively. The difficulty in measuring a simple functional trait of an extremely common and important species in coastal sage scrub is a complication that needs to be prepared for prior to data collection.

Species	SLM (mg/mm^2)	LDMC (mg/g)	TDMC (mg/g)	Twig Drying Time (hrs)	Degrees of Ramification	Fallen Litter ($g/100cm^2$)	Individual Biomass (g)
Eriogonum fasciculatum	0.378 ± 0.054 (19)^{A}	461.42 ± 11.78 (21)^{A}	591.03 ± 7.59 (33)^{A}	26.91 ± 1.38 (33)^{B}	4.947 ± 0.40 (19)	3.14 ± 0.45 (19)^{BC}	X
Artemisia californica	X	308.42 ± 45.85 (9)^{B}	579.28 ± 9.73 (34)^{A}	25.41 ± 0.98 (34)^{B}	4.888 ± 0.37 (18)	3.08 ± 0.35 (18)^{BC}	X
Acmispon glaber	0.313 ± 0.033 (22)^{A}	X	520.34 ± 23.23 (27)^{B}	24 ± 0 (27)^{B}	4 ± 0.14 (20)	2.41 ± 0.40 (20)^{C}	X
Salvia mellifera	0.184 ± 0.0092 (20)^{B}	353.54 ± 17.42 (24)^{B}	474.68 ± 7.87 (30)^{B}	48 ± 1.99 (30)^{A}	4.5 ± 0.37 (18)	4.64 ± 0.57 (18)^{AB}	X
Salvia apiana	0.2137 ± 0.0067 (8)^{AB}	420.46 ± 10.02 (24)^{AB}	411.36 ± 7 (27)^{C}	52.44 ± 2.87 (27)^{A}	4 ± 0.56 (8)	7.74 ± 1.55 (8)^{A}	X
Hirschfeldia incana	0.08571 ± 0.0051 (35)^{C}	X	X	X	X	X	1.91 ± 0.30 (42)
Centaurea melitensis	X	X	X	X	X	X	1.60 ± 0.22 (42)

Table 1: Functional trait means and standard errors of species sampled. The numbers in parentheses denote the sample size and "X" represents an absence of samples. Letters represent significant differences among species from the results of Dunn's Tests ($p < 0.05$).



- Five of the top ten species are invasive annuals.

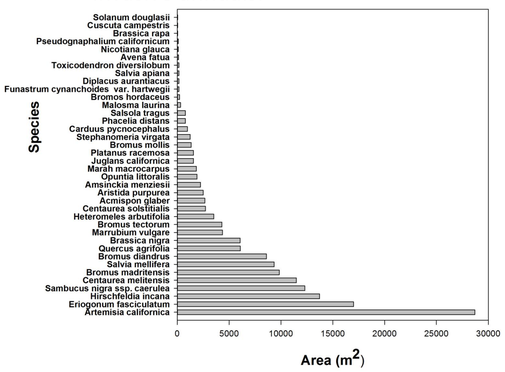


Fig. 1: The estimated coverage of plant species found in the Voorhis Ecological Reserve (excluding Box Canyon circled above).

- The fine fuels of *Centaurea melitensis* and *Hirschfeldia incana* constitute approximately half of the fine fuels measured.

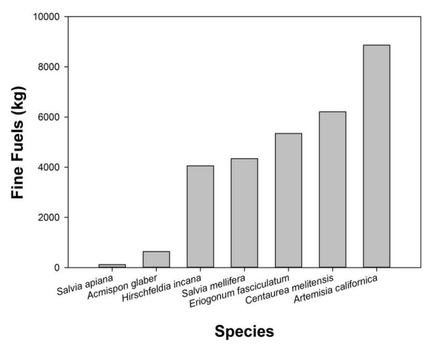


Fig. 2: An estimate of the fine fuels (in kilograms) that each species contributes throughout the Voorhis Ecological Reserve.

- *Centaurea melitensis* and *Salvia mellifera* (circled) exhibit relatively high fine fuels despite their lower percent cover.
- This result suggests that they contribute more to fine fuels than would be expected based on their abundance in the community.

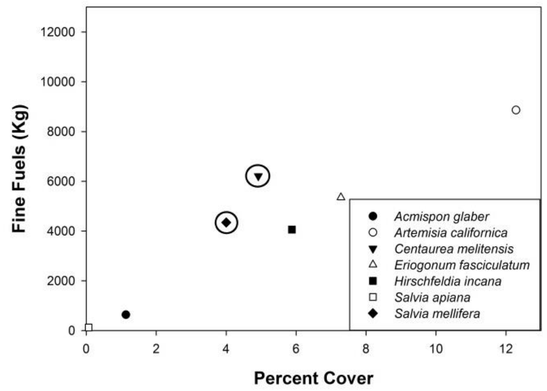


Fig. 3: The relationship between fine fuels and average percent cover of common shrubs and annual forbs in the Voorhis Ecological Reserve. These two components are significantly correlated ($r = 0.935$, $n_{(x,y)} = 7$, $p = 0.00198$).

Summary

- Plant invasions can affect native ecosystems by changing fuel properties such as fuel load and fuel continuity, causing alterations in the fire regime.
- In order to determine and compare the effects that native and invasive species have on fine fuels, we measured the functional traits of seven common species.
- We estimated the abundance of species throughout the reserve in order to determine how it fine fuels across the community.
- A significant correlation was found between the abundance of each species and its contributions to fine fuel throughout the community.
- *Salvia mellifera* and *Centaurea melitensis* contribute more fine fuel than would be expected based on their abundances.

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