Can woody weeds change fire intensity and behaviour?

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Introduction

An unknown number of alien plant species have been introduced to Australia. Differences in growth rate, plant architecture and ecophysiological characteristics among alien and native vegetation can alter fire regimes/behaviour and cause significant changes in the balance of carbon, nutrients and water.

Fire intensity has become one of the standard gauges by which fire managers estimate the difficulty of controlling a fire and determine appropriate suppression action. Quantification of the fire intensity at the fire front uses the Byram equation:

$$I = H.w.r.\ (MJ\ m^{-1}\ s^{-1})$$

Where: H is the specific heat of combustion (MJ kg^{-1}), w is the fuel load (kg m^{-2}) and r is the rate of spread (m s^{-1}).

H is defined as the energy released from complete combustion. In instances where specific values of H are not known, values of 15.5 MJ kg^{-1}, 18.7 MJ kg^{-1} or 21.4 MJ kg^{-1} have been used.The influence of invasive plants on fire behaviour, frequency and intensity may also vary according to the specific heat of combustion in each species.

Aim

This project aimed to investigate the leaf traits and combustion features of invasive woody plants in forests of eastern Australia.

Methods

Live leaves and twigs from mature plants (Table 1.) were randomly collected and stored in sealed plastic bags. Twenty fully expanded random leaves from each species were measured for leaf dimensions (length, thickness, area, perimeter). The remaining leaves were oven dried to constant weight and the gross heat of combustion determined by oxygen bomb calorimetry.

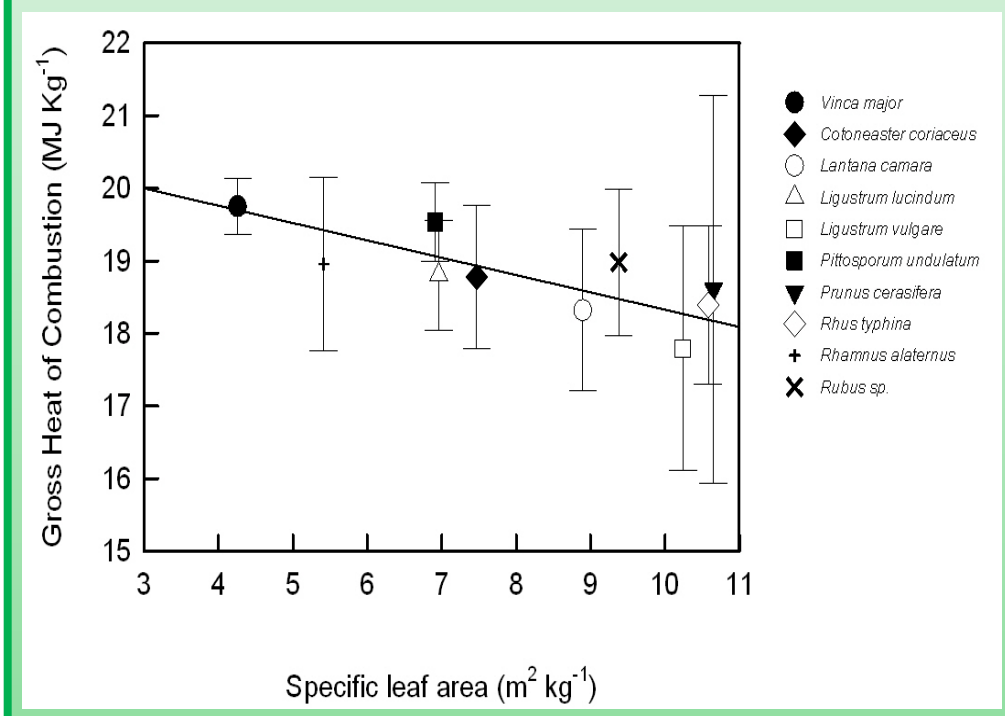
Table 1. Invasive species habits and occurrence in Australia

Species	Common name	Origin	Height (m)	Habit	Can form dense monoculture stands?	Occurrence NSW	QLD	VIC	SA	WA	ACT	TAS	NT
Acacia baileyana	Cootamundra wattle	NSW	3-6	Perenial	Yes	X	X	X	X	X	X		
Cestrum parqui	Green cestrum	South America	1-3	Perenial	Yes	X	X		X	X			
Cotoneaster coriaceus	Milkflower cotoneaster	China	1-4	Perenial	Yes	X	X		X		X	X	
Lantana camara	Lantana	Central America	2-4	Perenial	Yes	X	X	X	X	X	X	X	X
Ligustrum lucindum	Broad-leaf privet	China	1-12	Perenial	Yes	X	X			X	X		
Ligustrum vulgare	Common privet	Europe	2-5	Deciduous	Yes	X	X	X	X			X	
Ligustrum sinense	Chinese Privet	China	4-5	Perenial	Yes	X	X				X		
Olea europea sp. Cuspidata	Olive	Africa	2-10	Perenial	Yes	X							
Pittosporum undulatum	Swwer pittosporum	Eastern Australia	4-14	Perenial	yes	X			X	X		X	
Prunus cerasifera	Cherry plum	Europe	1-12	Deciduous	No	X		X	X	X	X	X	
Rhamnus alaternus	Italian Buckthorn	Europe	1-5	Perenial	Yes	X	X	X	X			X	
Rhus typhina	Staghorn sumac	North America	1-8	Deciduous	Yes	X		X	X			X	
Ricinus communis	Castor oil	African	3-5	Perenial	Yes	X	X	X	X	X			X
Rubus sp.	Blackberry	Europe	1-2	Perenial	Yes	X	X	X	X	X	X	X	X
Senna pedula var. *glabrata*	Climbing cassia	South America	2-4	Perenial	Yes	X	X	X					
Solanum mauritianum	Wild tobacco	South America	3-4	Perenial	Yes	X	X	X	X				
Vinca major	Bigleaf periwinkle	Europe	0.5	Perenial	Yes	X	X	X	X		X	X	

Results and discussion

Gill & Moore (1996) conducted a study of leaf litter flammability, identifying leaf surface area-to volume ratio, rather than leaf area, as the best predictor for fire intensity in dry material.

Our results show that specific leaf area (SLA) can provide a good insight of the energy released by leaves while burning. This variable could be quickly available in an emergency scenario. Taking in consideration the plant structure and environmental variables and the SLA, decision makers could take the right course of action to fight fire in invaded areas.



There is considerable variation in H within similar fuel types as well as between plant species and the current values used determine suppression actions represent average values of H for foliage, wood, stems and bark from a variety of species that compose that specific community.

The gross heat of combustion and the specific leaf area had a linear relation (r^2 = 0.70). Our preliminary results shows that different invasive species present a unique values of H. These values can be significantly different from the value used by Australian fire managers and can alter the fire behaviour of affected areas.

End user statement

Rapid alterations to native vegetation community composition and structure may occur following invasion by alien plant species. This has the potential to significantly affect fire behaviour in ways that are yet to be quantified. Research in this area will be essential, to determine what these impacts may be, allowing management strategies to be adapted to suit the changing environment.

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