

Fuel loads, fire severity, and tree mortality Florida Keys pine forests

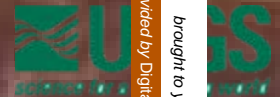


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The Pine Rocklands of South Florida



The Pine rocklands in the Lower Florida Keys:

➤ Habitat of the endangered

- Subtropical forests dominated by slash pine (*Pinus elliottii* var. *densa*)
- An endangered ecosystems
- Rich in flora including many endemic plant taxa.



Key Deer
(*Odocoileus virginianus clavium*)

The Pine rocklands and fire:

- Fire is important in shaping the structure and function of ecosystems.
- The endemic herb species require fire for their existence, survival, and reproduction.

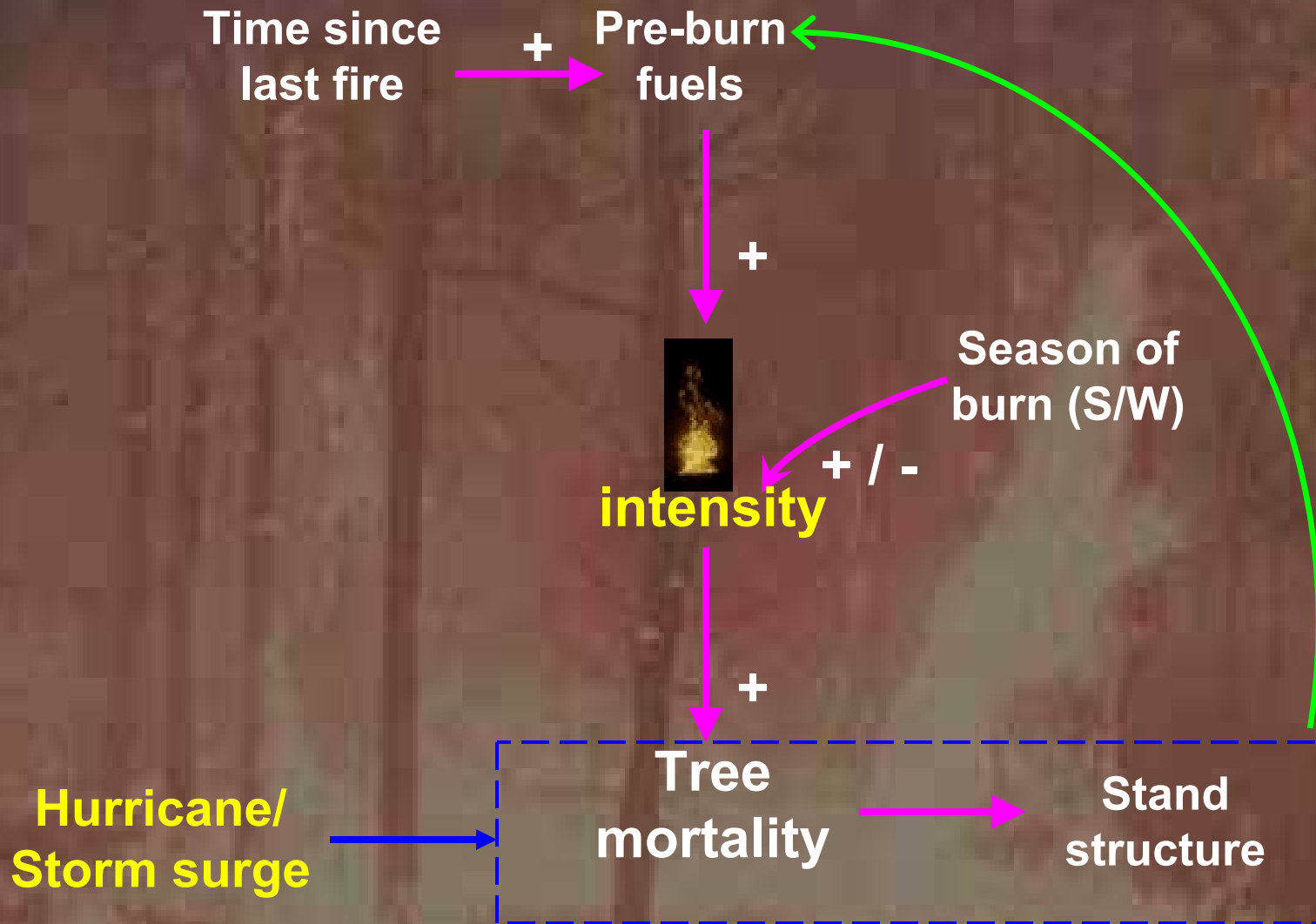
Without fire:

- succession towards a closed hardwood canopy
- loss of the characteristic pineland herb flora

Fire behavior depends on:

- Stand age & fuel availability
- Understory fuel types
- Season of prescribed burning

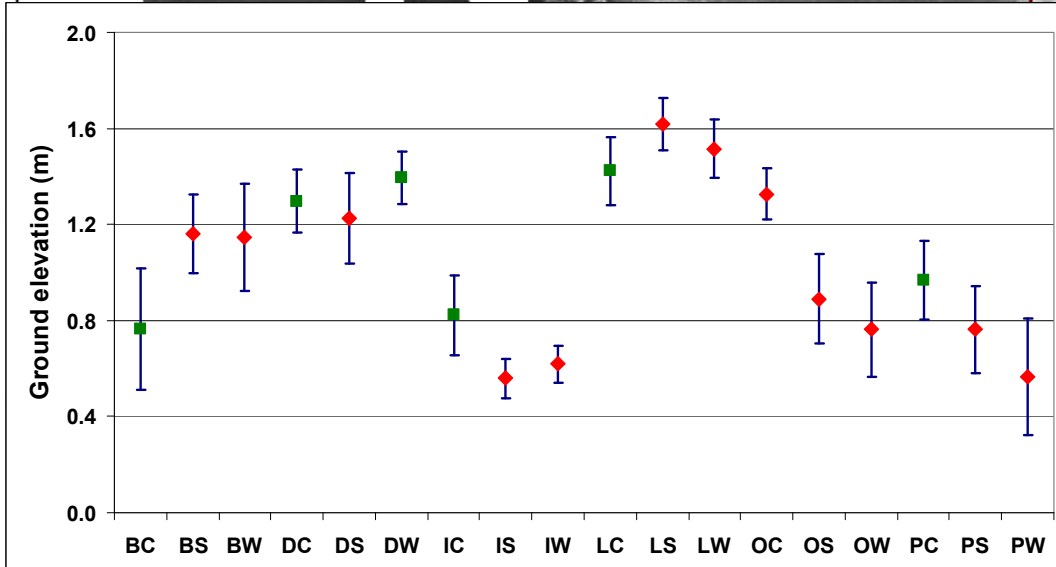
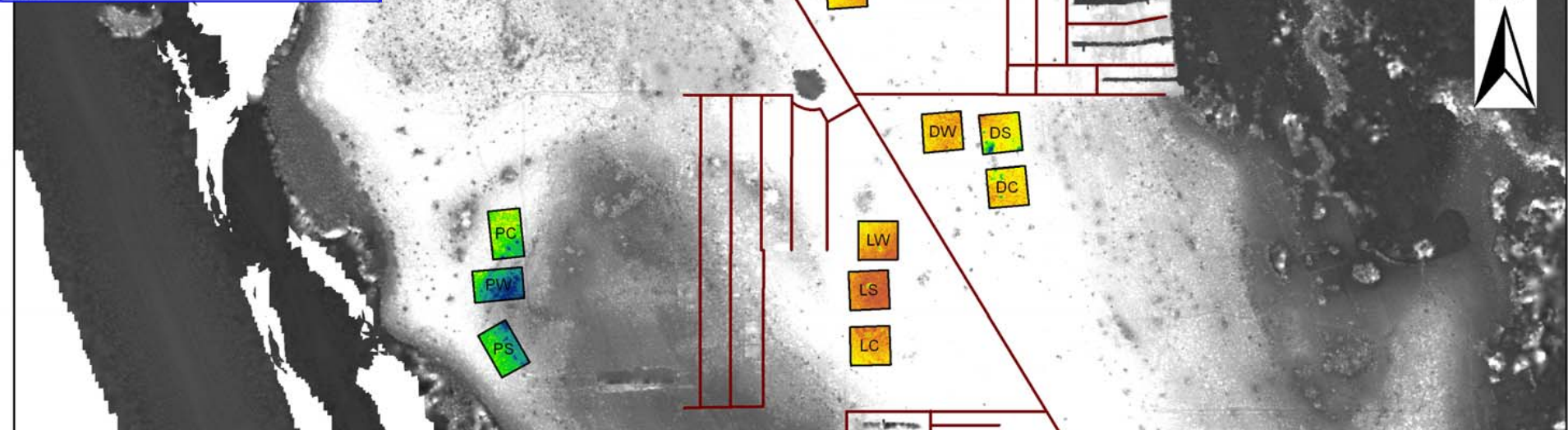
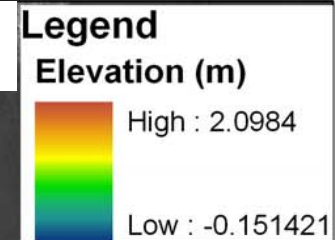




A conceptual model showing hypothetical relationships among fuel loads, fire behavior and tree mortality



BPK Experimental Plots



BPK Experimental burns & Tree monitoring

Site	Plot code	Burn Year	Post-burn Yr-1	Post-burn-Yr-2	Post burn-Yr-3		Post-hurricaneYr3
Orchid	OC	(2004)	1999	2000	2001		2008
	OS	1998 (S)					
	OW	1998 (W)					
Poisonwood	PC	—	2000	2001			2008
	PS	1998 (S)					
	PW	1998 (W)					
Iris	IC	—	2000	2001			2008
	IS	1999 (S)					
	IW	2000 (W)	2001				
Dogwood	DC	—	2000	2001			2008
	DS	1999 (S)					
	DW	—					
Locustberry	LC	—					
	LS	2001 (S)					
	LW	2001 (S)					
Buttonwood	BC	—					
	BS	2001 (S)					
	BW	2001 (S)					

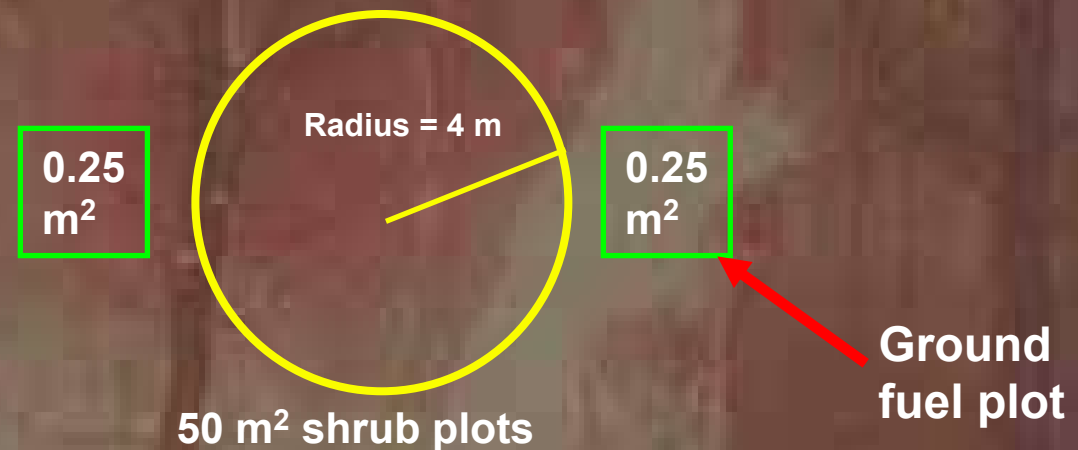
Methodology

Fire severity

- Char height
- Scorch percent

Fuel estimates

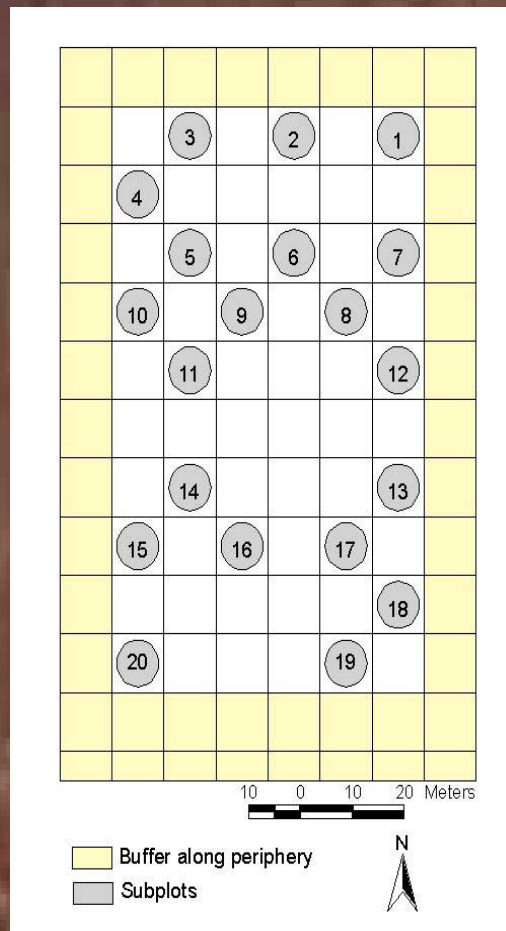
Shrub and Saplings (Ht >1m, dbh <5 cm)



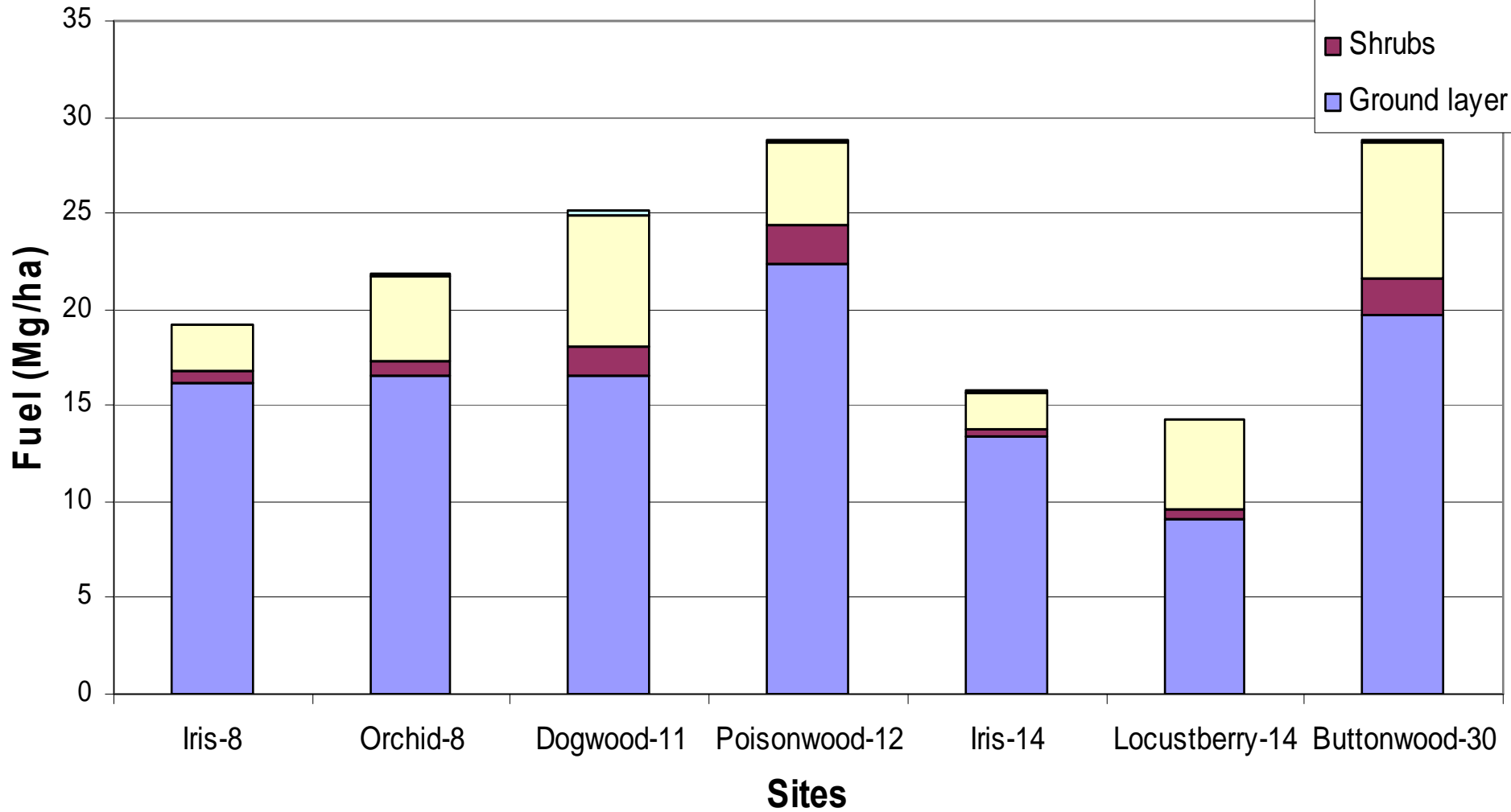
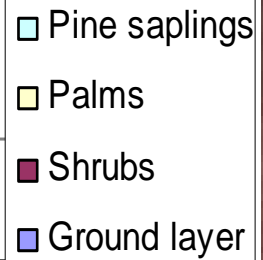
- Shrubs and Pine – allometric equations height and crown area or dbh
- Palms – Crown area and number of leaves

Ground layer (Height <1m)

- Harvest method

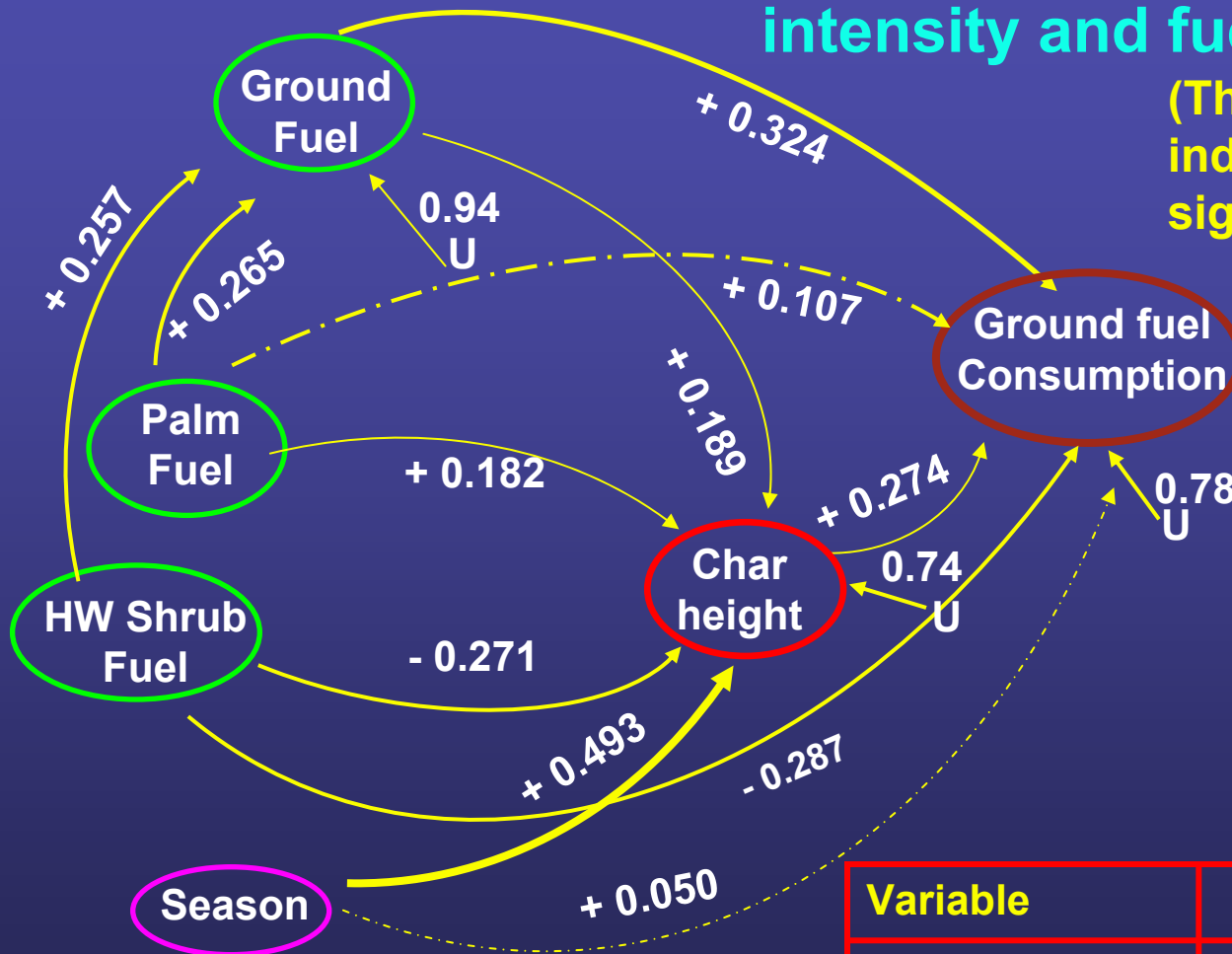


Understory fuels

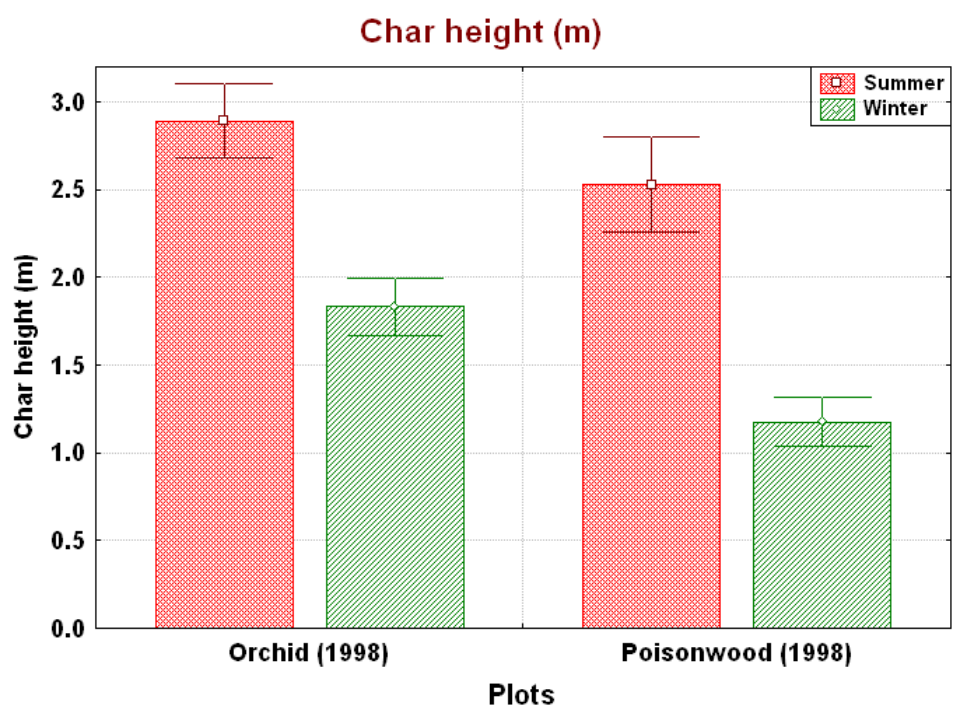
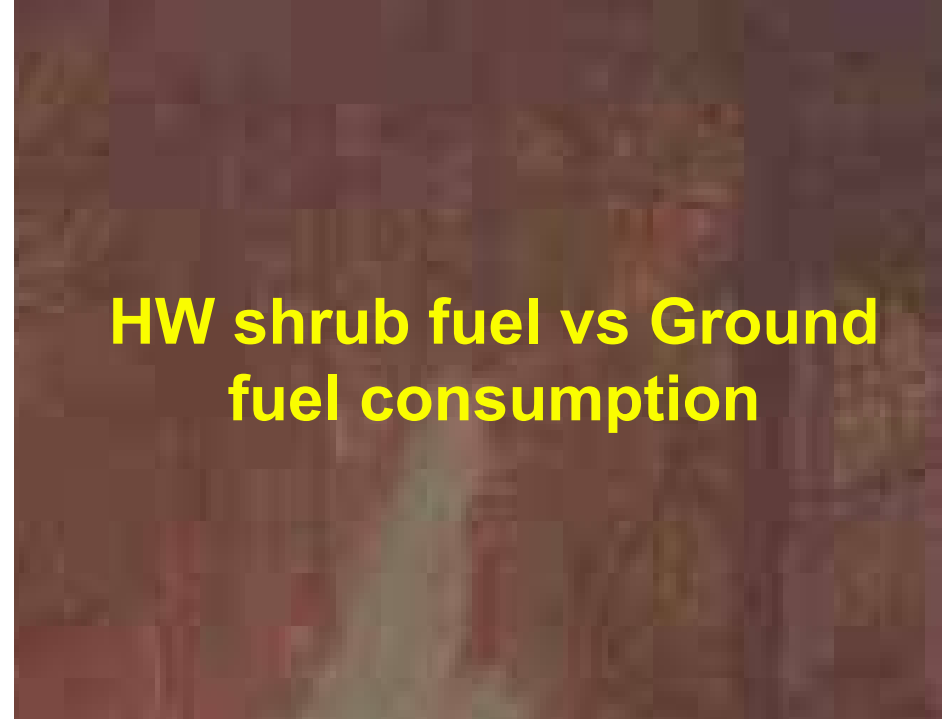
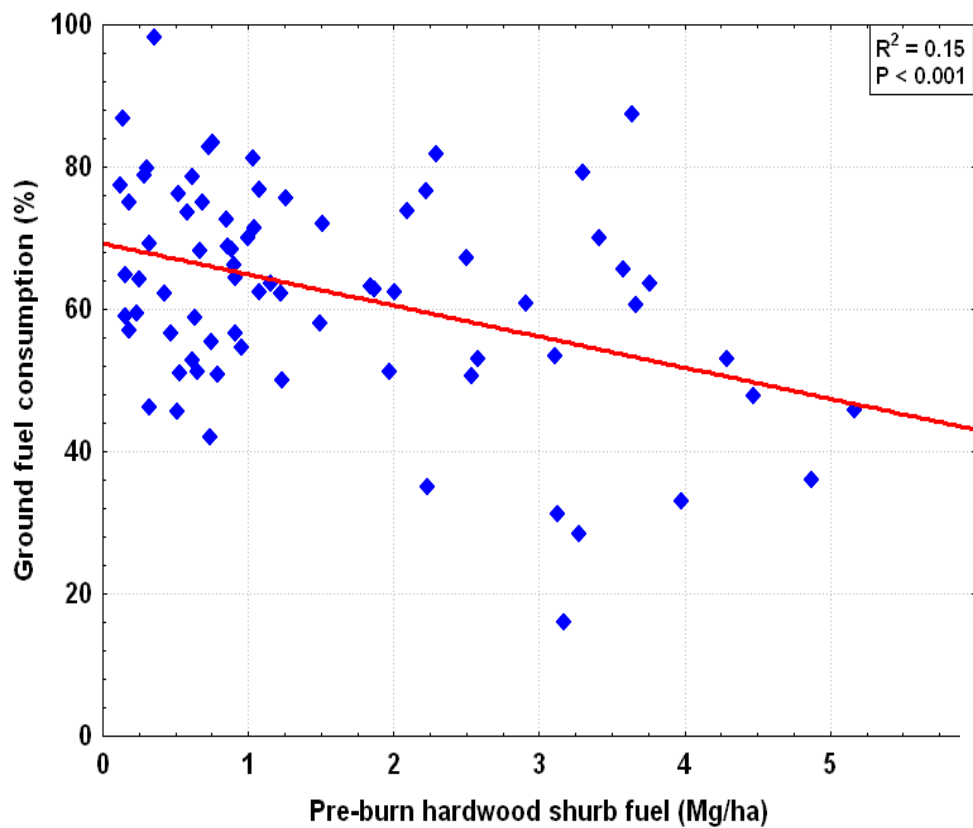


Path diagram showing the relationships among fuel types, fire intensity and fuel consumption.

(The thickness of lines indicates relative strength of significant correlations)



Variable	Direct	Indirect	Total
Ground fuel	0.32	0.05	0.38
Palm fuel	0.11	0.15	0.26
HW shrub fuel	-0.29	0.02	-0.27
Char height	0.27	Not modeled	0.27
Season	0.05	0.14	0.19

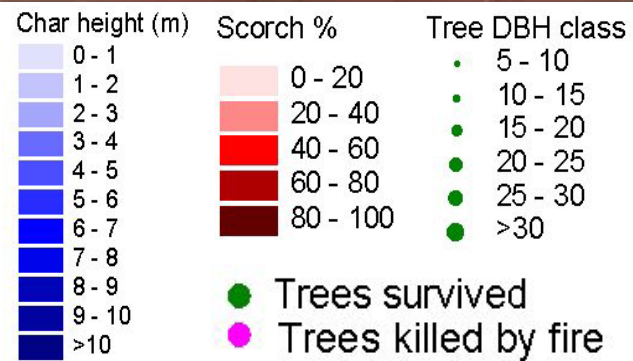
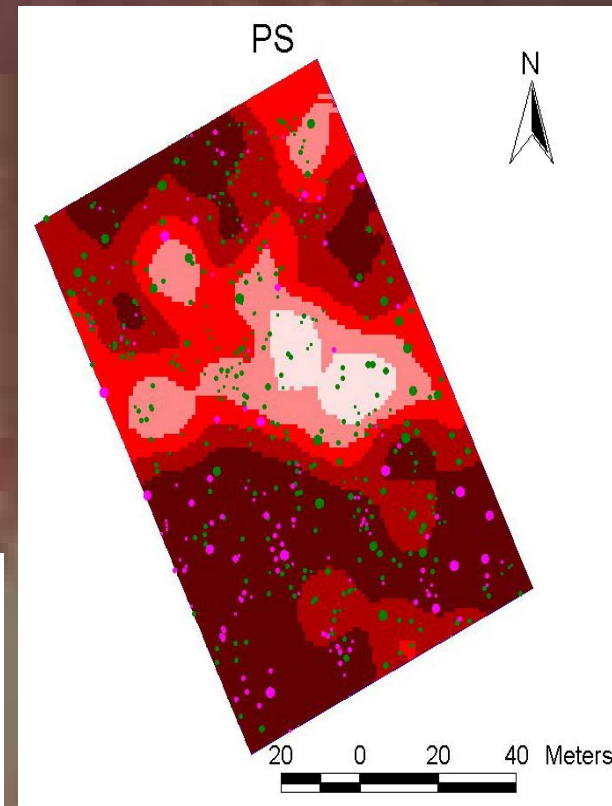
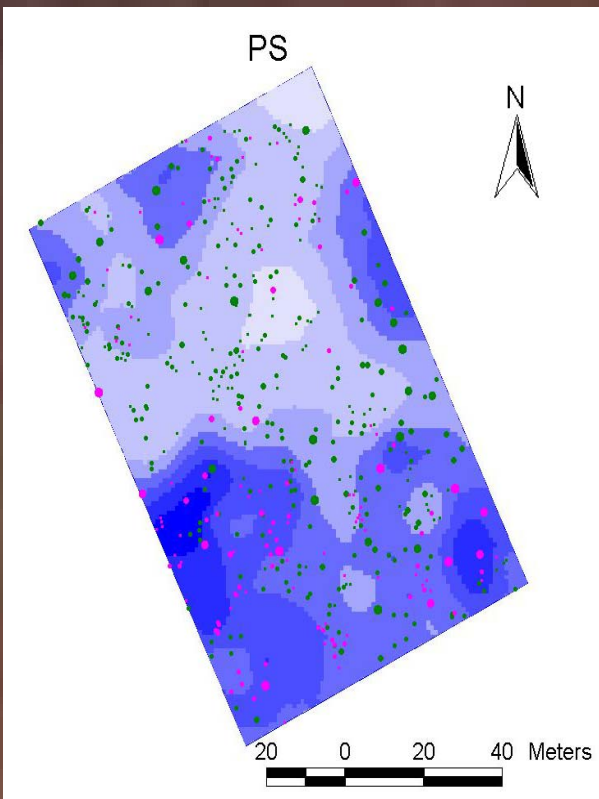


Char height

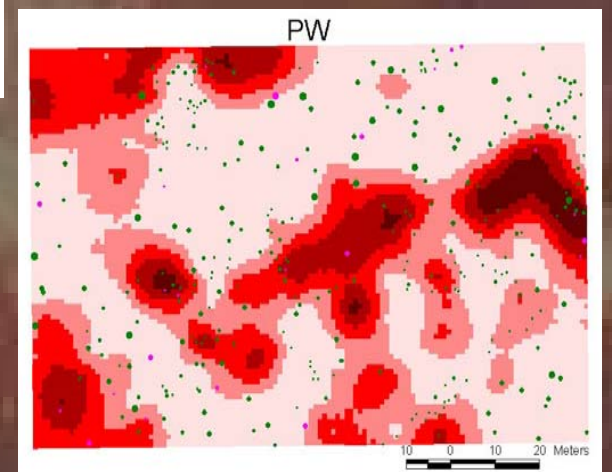
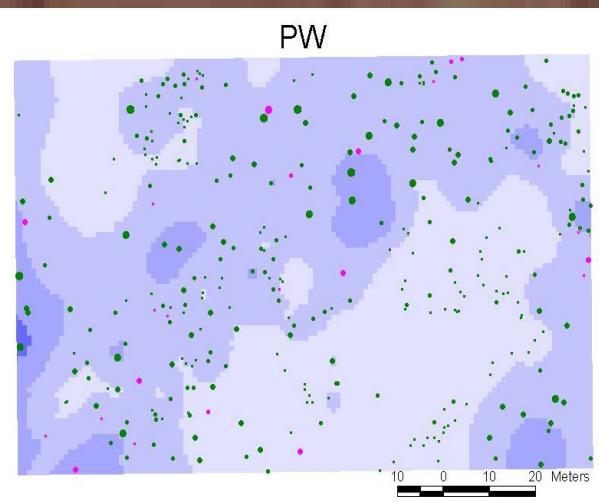
Scorch %

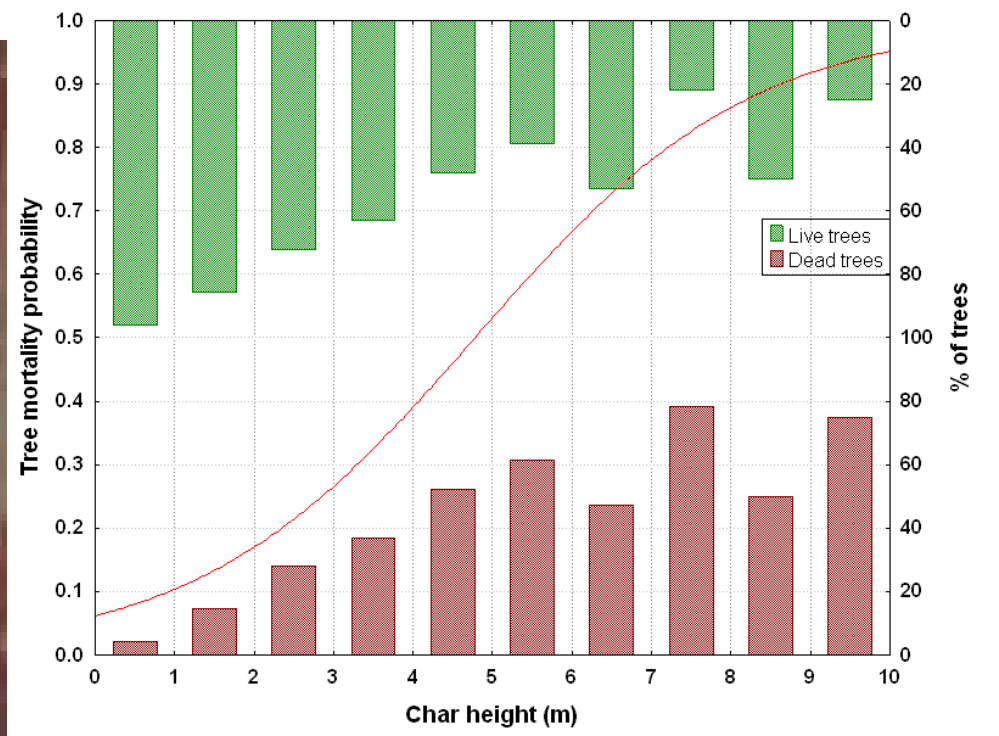
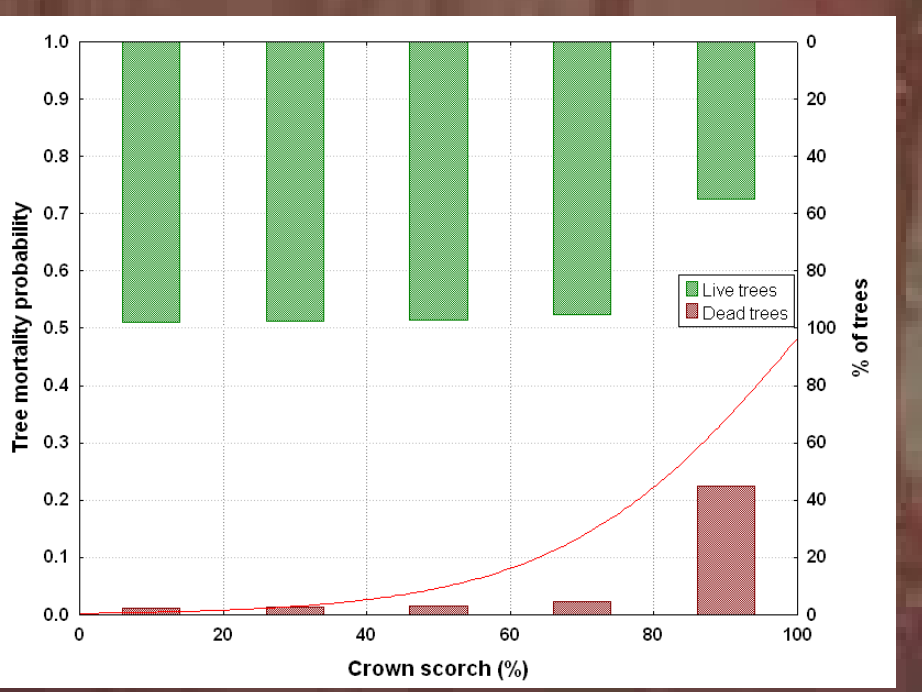
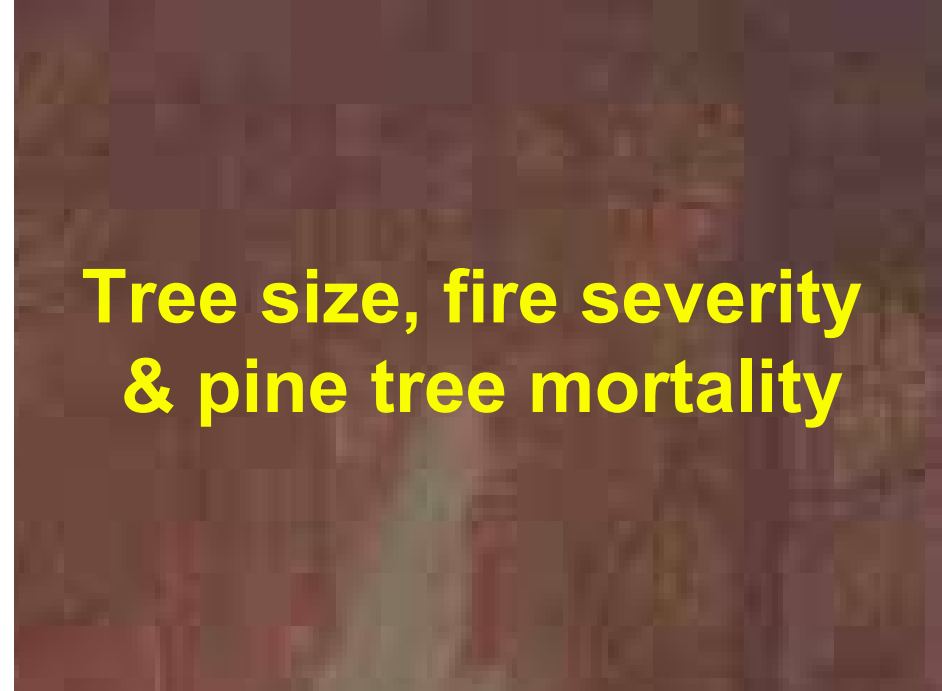
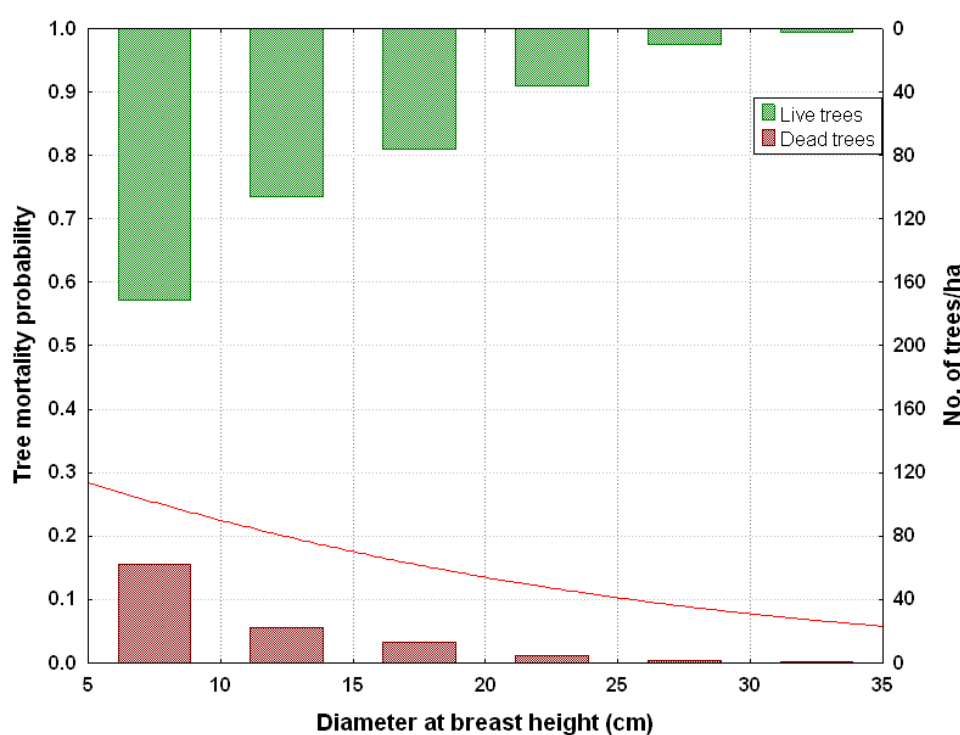
Site - Poisonwood

Summer burn

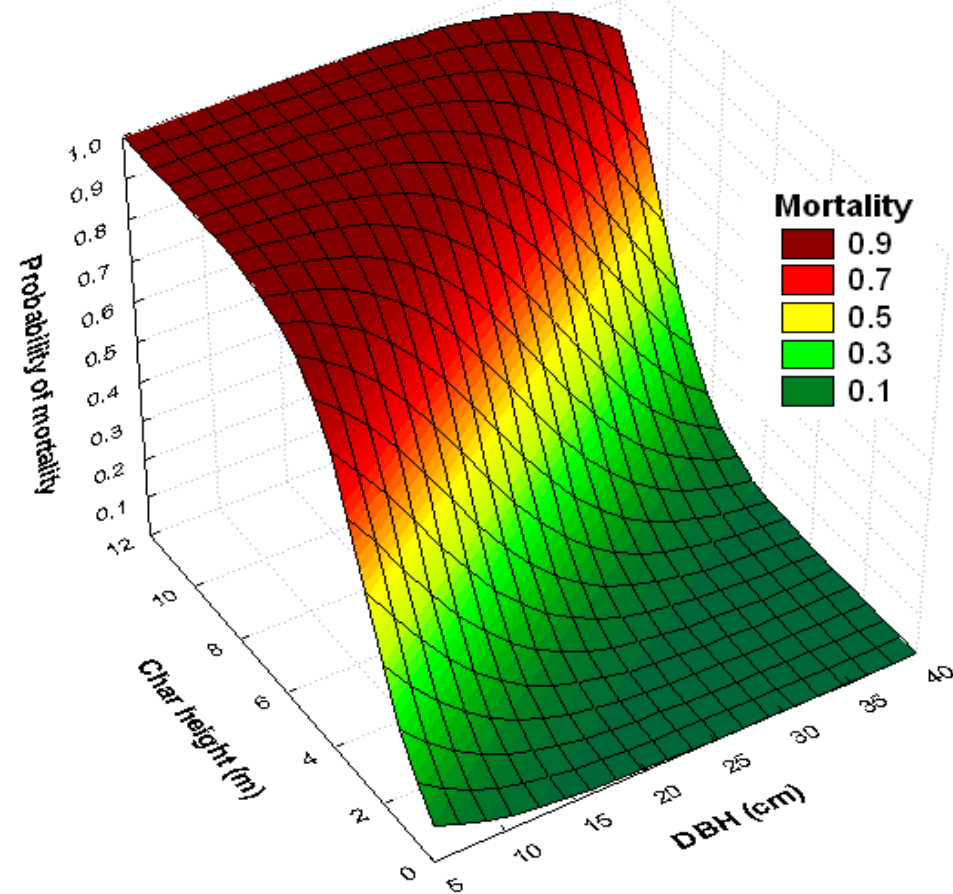


Winter burn





Tree size, char height & pine tree mortality



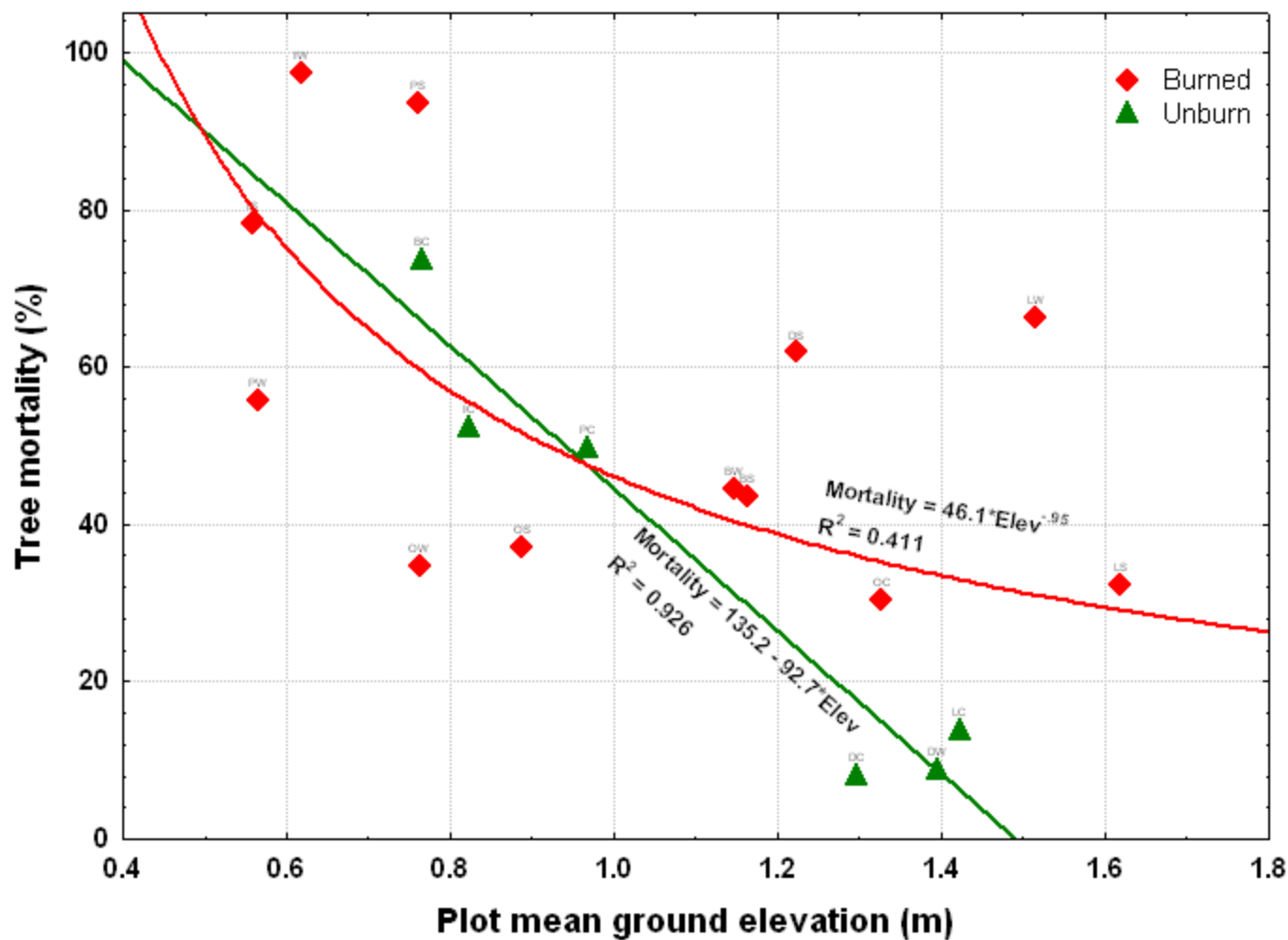
Tree size & Char height

$$P(m) = \frac{1}{1 + e^{-(-1.22 - 0.20 * DBH + 0.90 * CharHt)}}$$

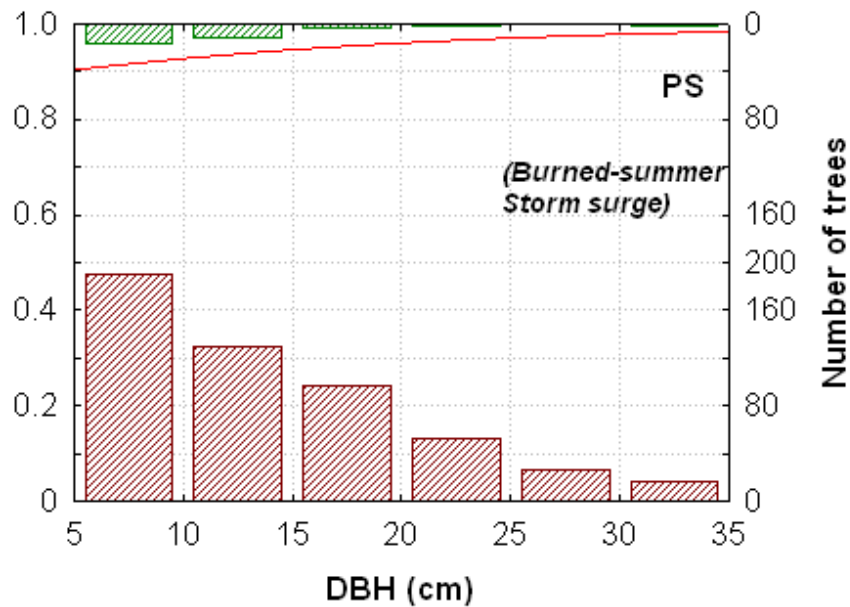
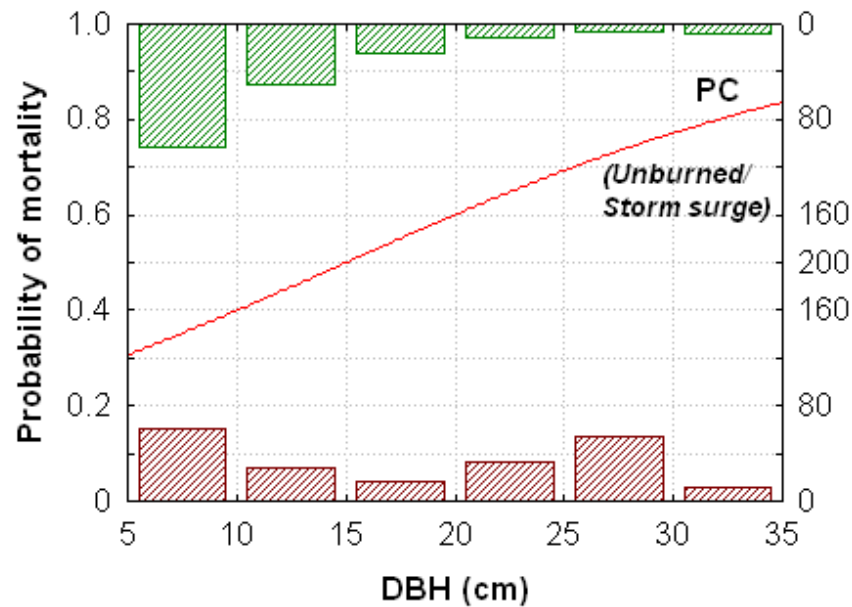
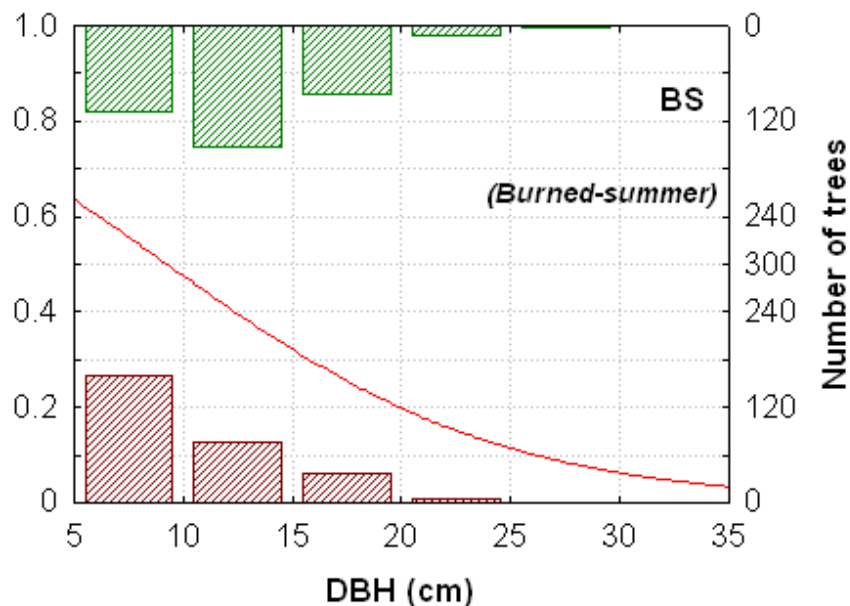
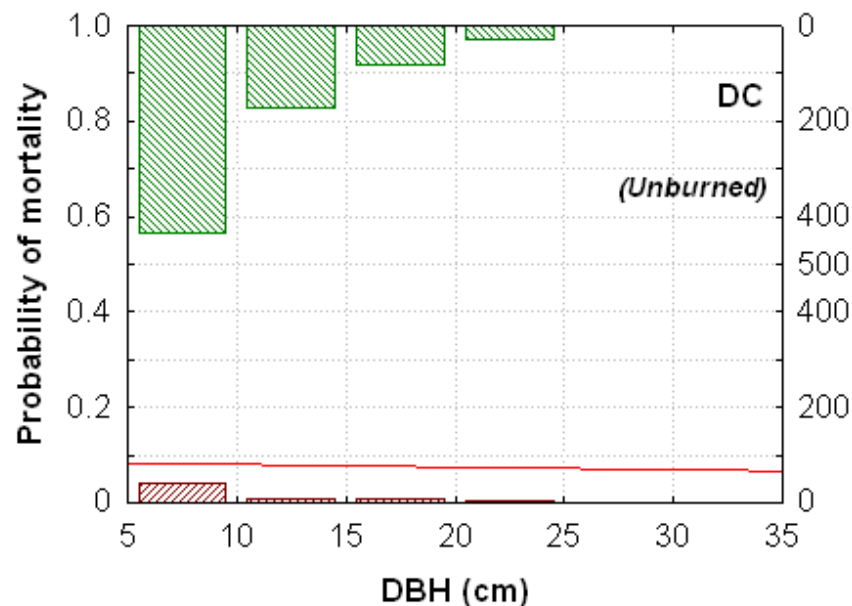
Probability of tree mortality in relation to DBH and Char height

DBH (cm)	Char height (m)									
	1	2	3	4	5	6	7	8	9	>10
5-10	0.112	0.212	0.386	0.632	0.838	0.921	0.968	0.982	0.995	0.998
10-15	0.047	0.095	0.203	0.397	0.612	0.807	0.915	0.969	0.986	0.994
15-20	0.018	0.038	0.094	0.212	0.411	0.629	0.820	0.891	0.957	0.988
20-25	0.005	0.016	0.036	0.086	0.193	0.424	0.591	0.795	0.935	0.963
25-30	0.002	0.006	0.015	0.039	0.100	0.206	0.441	0.641	0.727	0.928
>30	0.001	0.003	0.005	0.010	0.031	0.058	0.254	0.367	0.588	0.779

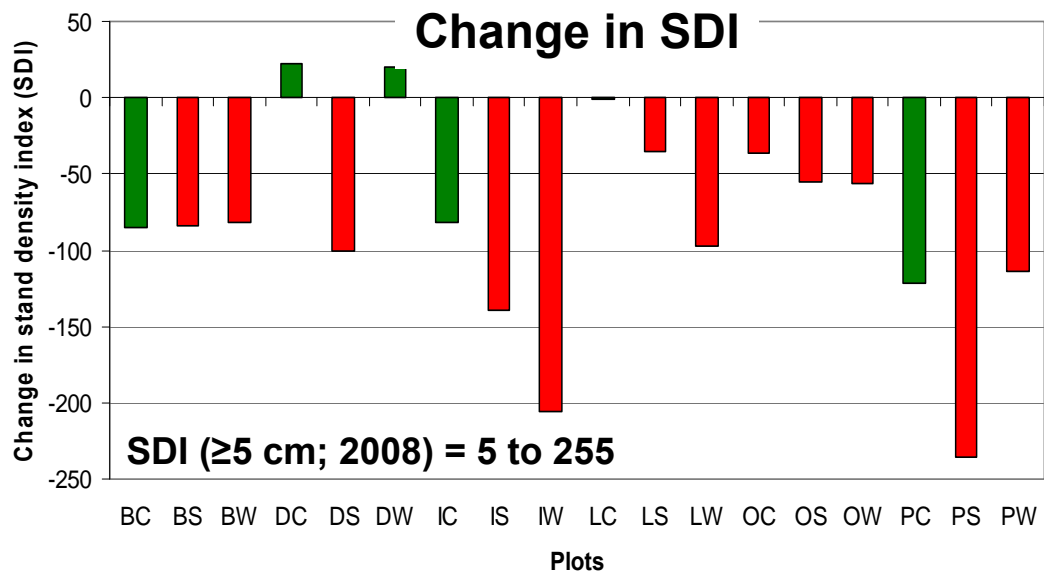
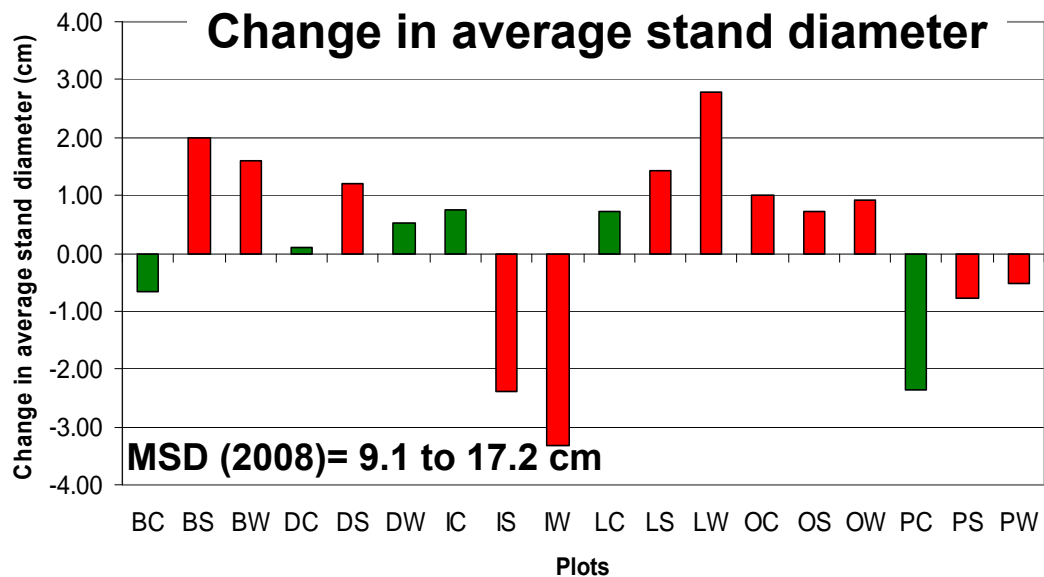
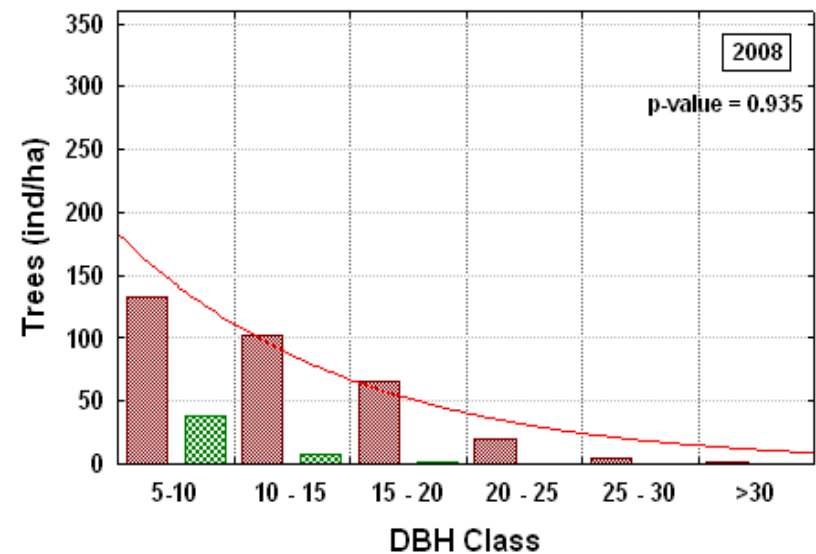
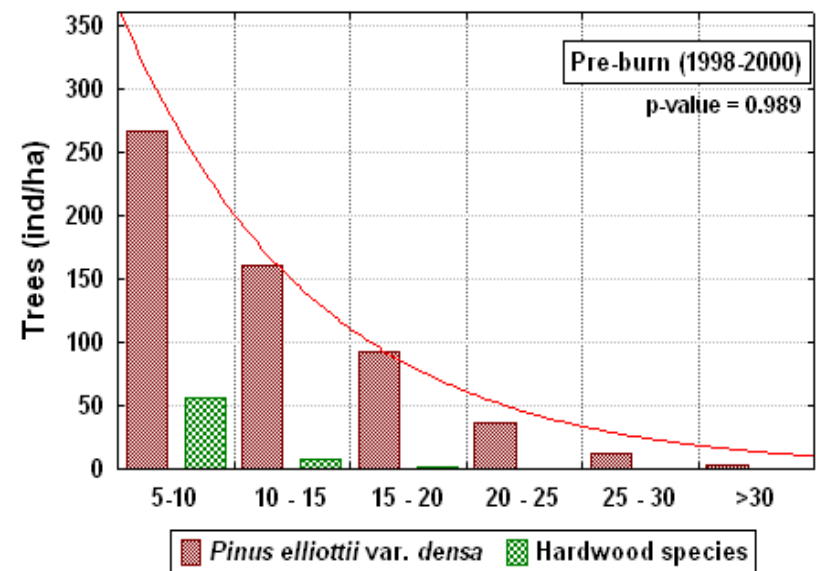
Mean ground elevation vs fire and storm surge (2005) induced cumulative pine tree mortality



Logistic model – tree mortality in relation to dbh



Stand structure in BPK Pine forest



Conclusions

- Fire intensity increased with surface fuel loads, but was negatively related to the quantity of hardwood shrub fuels. probably because these fuels are associated with a moist microenvironment within hardwood patches, and therefore tend to resist fire.
- Winter fires were milder than summer fires, however effects of season on tree mortality varied among sites.
- Fire-induced mortality was higher in small tree classes, whereas storm surge effects were concentrated on large trees.
- The stand structure pine forests in Big Pine Key has changed quantitatively over the decade, primarily due to effects of both fire and storm surge-caused tree mortality.



Acknowledgements

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